SCIENCE ABSTRACTS.

Section A.—PHYSICS.

DECEMBER 1903.

GENERAL PHYSICS.

1300. *Double-acting Mercury Pump.* **F. Neesen.** (Zeitschr. Instrumentenk. 23. pp. 47–49, Feb., 1903.)—This pump appears to be somewhat similar to the double-piston pump referred to in Abstract No. 1271 (1902). In the present arrangement two complete pumps are caused to act alternately by means of a plug-cock controlling the motion by atmospheric pressure of the mercury from the "boots" or mercury-reservoirs at the bottom of the apparatus to the vessels from which the air is swept by the mercury. The air thus swept out is removed by an auxiliary pump which also effects the preliminary exhaustion of the said vessels and of the receiver. The plug of the controlling cock above mentioned bears two arms, to one of which is secured a counterweight, and from the other is suspended a glass vessel. This vessel is connected between the mercury system of one of the pumps and a kind of cataract-pipe, so that the counterweight and the suspended vessel alternately overbalance each other and thus move the plug of the cock alternately in opposite directions. In the original paper the arrangement of the connecting pipes and valves is shown in a lettered photograph. In order to prevent mercury being carried off by the auxiliary pump, a bulb containing a special form of baffle is arranged between this pump and each of the vessels from which the air is swept. C. K. F.

1301. *Volumenometer for the Determination of the Density of Small Quantities of Substance.* **L. Zehnder.** (Ann. d. Physik, 10. 1. pp. 40–71, Dec. 30, 1902.)—The substance is placed in a small stoppered bottle, the internal volume of which is accurately known, and the bottle is then introduced into the vacuum of a mercurial barometer. The air enclosed in the bottle at the time of filling diffuses out into the space over the mercury, the volume of which is known in terms of the volume of the barometer tube, of the material of the bottle, and that of the substance. This total volume is also known in terms of the original volume of the air and the ratio of its original to its final pressure, which the apparatus is designed to measure. The volume of the substance can then be calculated. The chief source of error is the small quantity of air which clings to the surface of the bottle and to the inner surface of the tube, and which expands when the pressure is reduced. This cannot be avoided, but the author has shown that by making an observation with the bottle containing air only, or containing a known volume of some substance, such as mercury, this error may be determined and allowed for. The method of calibrating the apparatus is described in great detail, and the author suggests that this might be done by the instrument maker; also that as the actual manipulation is easy and can be rapidly performed, his method affords a means of determining density, of wide applicability, and of special usefulness to chemists and mineralogists, who frequently require to know the density of a substance of which only a small quantity is available, and that in the form of powder. The results of a determination of the density of sugar are given, the masses of sugar used in three experiments being respectively 0·1645 gr., 0·2484 gr., and 0·2004 gr., the densities being found to be 1·601, 1·582, and 1·585. In the first of these three, two pieces of sugar were used; in the second, 100 small grains; and in the third, the sugar was finely powdered. The author further claims that each determination, together with the control experiment for determining the amount of air accidentally carried into the tube, can be performed in half an hour. S. G. S.

1302. *Throw-Testing Machine for Reversals of Mean Stress.* **O. Reynolds** and **J. H. Smith.** (Roy. Soc., Phil. Trans. 199. pp. 265–297, Sept., 1902. Roy. Soc., Proc. 70. pp. 44–46, May 12, 1902.)—The author describes the machine used in this research which was carried out in the Whitworth Engineering Laboratory, Owens College. Evidence of two general laws was obtained, viz.: (1) That under a given range of stress the number of reversals before rupture diminishes as the frequency increases; (2) that hard steels will not sustain more reversals with the same range of stress than mild steels when the frequency of the reversals is great. The paper is not suitable for abstracting, but the following are the headings of the contents: Historical Summary; Objects of Research; Method of Applying the Stress; Complete Description of the Apparatus; Determination of the Stress; Modes of Vibration of a Specimen; The Specimens—preparation, annealing, fixing; Method of Conducting the Tests; Preliminary Tests for Mild Steel; On the Restoring Effect of a Period of Rest; Relation of Limiting Range to Periodicity of Reversals; Summary of Results; Conclusion. C. C.

1303. *Strength of Glass.* **B. Galitzin.** (Acad. Sci. St. Pétersburg, Bull. 16. pp. 1–29, Jan., 1902.)—The strength of glass does not depend appreciably upon the speed with which the pressure within a glass tube rises, nor upon the absolute thickness of the tube, but upon the ratio of the radii, R/R′. In general the thicker the walls, the more chance there is of flaws. The average number of atmospheres' pressure which glass tubes may stand, though it is not advisable to apply more than half these pressures, is as follows:—

Ratio of radii.		1·05	1·10	1·15	1·20	1·25	1·30	1·35	1·40	1·45	1·50
Internal pressure in atmospheres.	Jena glass.........	17	36	58	81	108	134	162	190	219	253
	Thuringian glass	19	40	66	94	125	157	193	203	206	209

Ratio of radii.	1·55	1·60	1·65	1·70	1·75	1·80	1·85	1·90	1·95	2·00	2·06	2·10	2·15	2·20	2·25	2·30	2·35
Int. pressure, Thuringian glass only	210	209	210	215	218	220	222	223	228	233	238	237	241	245	249	258	261

A. D.

1304. *Absolute Units.* **G. Dompieri.** (Zeitschr. Elektrotechn., Wien, 21. pp. 137–141, March 8, 1903.)—In order as far as may be to get rid in calculations of 60 and 60 × 60, 75 (for horse-power), *g*, and the factors 10^9, 10^{-9}, &c., the author recommends a system which he works out in detail based upon: As unit of time $\frac{1}{10000}$ hour; as unit of length the centimetre; as unit of mass the mass which produces a unit gravitational acceleration in equal mass at one unit distance; and as unit of force the gravitational attraction between two units of mass unit distance apart. On such a system all electrical and magnetic dimensions are in [L, T] only. Other systems also discussed and compared. A. D.

1305. *Energy Theory in Mechanics.* **G. Zemplén.** (Ann. d. Physik, 10. 2. pp. 419–428, Jan. 27, 1903.)—In developing his theory of energy, Ostwald enunciated as a general law applying to all natural phenomena the following principle: "Of all possible energy-transformations, that one will actually occur which involves the greatest possible 'turn-over' (Umsatz) of energy in a given time," and showed that in the case of a heavy particle moving vertically under the influence of gravitation this principle led to the known dynamical equation of motion. It was subsequently shown by Carl Neumann that in the case where the velocities of all the points of a given system were initially zero, Ostwald's principle led to the Newtonian differential equations of motion for the *initial* motion of the system. In spite of the fact that Boltzmann has already pointed out that this principle is not generally true, several authors—*e.g.*, Januschke and Dressel—have attributed to it a universal application. The present author seeks to throw light on the matter by deducing the general differential equations of motion of a point-mass to which Ostwald's principle leads, and comparing these equations with those yielded by the Newtonian laws of motion. The point-mass is supposed to move on a surface, $\phi(x, y, z) = 0$, where the function ϕ does not involve the time or the time-fluxions of x, y, and z explicitly. Denoting by X, Y, Z the components of the force acting on the point at time t, and by u, v, w, T the corresponding velocities and the kinetic energy, the condition that $T_{t+\tau} - T$ should possess a stationary value (τ being a small constant time-element), together with the law of conservation of energy and the prescribed condition $\phi(x, y, x) = 0$, leads to the equations of motion $X + \rho\frac{\partial\phi}{\partial x} = \frac{mu}{2}\frac{d}{dt}(\log T)$; $Y + \rho\frac{\partial\phi}{\partial y} = \frac{mv}{2}\frac{d}{dt}(\log T)$; $Z + \rho\frac{\partial\phi}{\partial z} = \frac{mw}{2}\frac{d}{dt}(\log T)$. These equations differ in two essential points from the Newtonian equations: (*a*) the force-components $X + \rho\frac{\partial\phi}{\partial x}$, &c., are proportional to the velocities and not to the accelerations; (*b*) each force-component depends not only on the change of motion in its direction, but also on the change in the total kinetic energy of the mass. If, however, at time t, $u = v = w = 0$, the equations reduce to the Newtonian equations as shown by Neumann. Again, if the motion of the point be a rectilinear motion parallel to the axis of x, then $v = w = 0$ for all values of t, and we have $\frac{mu}{2}\frac{d}{dt}\left(\log \frac{u^2}{2}\right) = \frac{mu}{2}\cdot\frac{2u}{u^2}\cdot\frac{du}{dt} = m\frac{du}{dt}$, so that we have now $X + \rho\frac{\partial\phi}{\partial x} = m\frac{du}{dt}$, *i.e.*, the Newtonian equation. Ostwald's principle cannot therefore be applied in general to determine the motion of a system. We can prove quite generally, however, that in the case of the motion of an unconstrained point-mass, Ostwald's principle suffices to determine the whole motion, when, and only when, the motion is rectilinear. For if the equations $2X = mu \frac{d}{dt} \log T$; $2Y = mv \frac{d}{dt} \log T$; $2Z = mw \frac{d}{dt} \log T$; and $X = m \frac{du}{dt}$; $Y = m \frac{dv}{dt}$; $Z = m \frac{dw}{dt}$, are to hold simultaneously for every value of t, then we must have $\frac{\dot{u}}{u} = \frac{\dot{v}}{v} = \frac{\dot{w}}{w}$, *i.e.*, $\log u = \log v + B = \log w + C$, where B and C are independent of t; hence $u = Bv = Cw$, *i.e.*, the motion must be rectilinear. The author points out, in conclusion, that it would still be possible to build up a mathematically consistent dynamical scheme founded on Ostwald's principle, but that this would involve not only the assumption of non-Newtonian forces, but also of different fundamental axioms, of which the following would be the analogue of Newton's first law: "A point-mass uninfluenced by any forces will continue to traverse any curve whatsoever, preserving, however, the constancy of its kinetic energy." Such an "axiom," however, exhibits the indeterminate character of the system.

[In the case of a system initially at rest, where Ostwald's principle applied to the *initial* motion leads to the true equations of motion, it would be interesting to know what connection this theorem possesses with the maximum and minimum theorems discussed by Thomson and Tait, pars. 314–317 (Vol. I.).] F. G. D.

1306. *Dielectric Cohesion of Mixtures of Gases.* **E. Bouty.** (Comptes Rendus, 136. pp. 669–671, March 16, 1903.)—The effluvium which illuminates a gas when its dielectric cohesion breaks down does not operate any chemical change in a mixture of gases; it does not explode an explosive mixture nor induce the slightest fall of pressure in it. As a rule, the cohesion of a mixture (such as CO and CO_2, or H and CO) is intermediate between the cohesions of its components, and is in most cases a true arithmetical average according to the proportion of each component; and this is the case even with mixtures of H and N_2O, up to pressures of 60 mm. Hg. But with H and CO_2 the critical field is a good deal below this average, and the amount of fall asymptotically increases with the pressure; but neither with H and CO_2 nor with H and O is there any production of H_2O. There seems to be a disturbance of molecular stability without any actual chemical effect. At low pressures all mixtures containing hydrogen have a low critical field, apparently due to disturbance of the molecular stability at or near the walls of the vessel. A. D.

1307. *Inertia and Coercion.* **L. Natanson.** (Journ. Phys. Chem. 7. pp. 118–127, Feb., 1903. Lecture delivered at the annual meeting of the Cracow Academy of Sciences.)—The scope and general purport of this extremely interesting and profound essay may perhaps be briefly summarised as follows: (I.) What has been as yet achieved in science is a mere beginning. (II.) The phenomena of inanimate nature may be divided into two categories: those which bear a character of permanence, like the motion of the planetary systems, or those periodical rhythmic wave-motions which are perpetually rolling through the boundless, all-pervading ether; this permanence is what is meant by inertia: and those which tend to subside, like diffusion of heat or matter, where we perceive the operation of coercion. (III.) Nature is many-sided. In order to grasp its laws we are forced to regard phenomena from a one-sided aspect, to mentally isolate what we call distinct classes of phenomena, which are in reality indissolubly connected with the whole complex of natural events. (IV.) This artifice is necessary at the outset of any science, but is incompatible with the intrinsic harmony and unity of Nature, and must disappear with the development of science. (V.) Thermodynamics is an attempt to do away with restricted standpoints ; it is a theory which discards such artificial divisions of phenomena. Thermodynamics has established a general theory of equilibrium and reduced chemistry to scientific order. In the equations of equilibrium established by thermodynamics we can see the generalisation of the statical principle of virtual work. Thus thermodynamics has absorbed the science of statics. (VI.) But equilibrium is only a limit to phenomena ; knowing it, we know but the surface of reality. We must go on to study the laws which preside over the *progress* of phenomena. Fourier's theory of heat-conduction is a magnificent example of this. (VII.) Can we venture on a scheme of generalisation applicable to all that happens? Consider as the quantitative expression of the progress of a phenomenon a *flux* of a certain quantity in unit time across unit surface. Such a flux depends on what we may term the *stimulus—e.g.*, space-gradient of velocity, density, temperature. The flux is approximately proportional to the stimulus. But the stimulus does more than produce the flux—it continually changes its intensity, produces *impetus.* Why is this impetus often so very slight (as in the case of heat-conduction)? Because it is thwarted by a latent resistance always ready to act in material bodies, namely coercion. But coercion cannot do away entirely with inertia. Thus even heat possesses inertia. There is one instance of inertia without coercion—*i.e.*, phenomena displayed in pure ether. But there is no true instance of coercion without inertia. (VIII.) In Lagrange's equations and Hamilton's principle of varying action we have the highest generalisations of dynamics ; in Gibbs's equations the highest generalisation of thermodynamics as it is at present. But consider a pendulum oscillating in a viscous fluid, or a crystal of salt dissolving as it drifts down a river. Neither generalised dynamics nor thermodynamics can deal with such cases. They belong to the province of *Thermokinetics*—a province explored as yet by only a small band of students, with Duhem at their head. Thermokinetics bears the same relation to the Lagrangian equations and Hamilton's principle that modern generalised equilibrium-thermodynamics bears to the fundamental proposition of Statics. F. G. D.

1308. *Free Vibrations of Systems Affected with Small Rotatory Terms.* **Rayleigh.** (Phil. Mag. 5. pp. 293–297, March, 1908.)—If ϕ_1, ϕ_2, &c., be the coordinates defining a system of this nature, the equations may, in the absence of dissipation, be put in the form $a_1\ddot{\phi}_1 + c_1\phi_1 + \beta_{12}\dot{\phi}_2 + \beta_{13}\dot{\phi}_3 + \&c. = 0$; $a_2\ddot{\phi}_2 + c_2\phi_2 + \beta_{21}\dot{\phi}_1 + \beta_{23}\dot{\phi}_3 + \&c. = 0$, &c., and, by the conditions, all the coefficients β are very small. Also $\beta_{rs} = \beta_{sr}$. If there were no β terms, these equations would be satisfied by assuming $(c_r - \sigma_r a_r)\phi_r = 0$, and all the other ϕ's zero. In the actual case there will *in general* be a corresponding solution in which any ϕ_s is not zero, but small compared with ϕ_r. It follows that σ_r is approximately the same as if there were no rotatory terms. And on this property depends the solution of the problem. If in the equation for ϕ_s we admit only β_{sr}, we can by comparison with $(c_r - a_r\sigma_r^2)\phi_r = 0$ obtain ϕ_s/ϕ_r. He next finds σ_r to a further approximation, admitting β_{rs}^2, namely, $a_r\sigma_r^2 = c_r + \Sigma \dfrac{\sigma_r^2\beta_{sr}^2}{a_s(\sigma_r^2 - \sigma_s^2)}$, whence it appears that the effect of the introduction of β_{rs} is to increase the absolute value of $\sigma_r^2 - \sigma_s^2$. Reference is made to the example of a circular membrane vibrating with one diameter nodal. If there be any excentric load, the nodal diameter must either pass through the load or be at right angles to the diameter which passes through it (Theory of Sound, § 208). The effect of the load is to separate two originally coincident frequencies. The case in which there are originally two normal nodes having equal frequency ϕ_1 and ϕ_2 is worked out at length. S. H. B.

1309. *Vibrations of a Rectangular Sheet of a Rotating Liquid.* **Rayleigh.** (Phil. Mag. 5. pp. 297–301, March, 1903.)—This problem is analogous to the one treated in the preceding Abstract, and the method adopted is in principle the same, namely, to find a solution when a certain condition ($n = 0$) is accurately fulfilled, and to extend that to approximate solutions, when the condition is fulfilled only approximately. The problem has been solved for a circular sheet of gravitating liquid. For a rectangular sheet the analysis is much more difficult. In this paper a solution is given for the case in which the velocity of rotation is small. The motion being proportional to $e^{i\sigma t}$, the fundamental equations are—

$$\left.\begin{aligned} i\sigma u - 2nv &= -g\frac{d\zeta}{dx} \\ i\sigma v + 2nu &= -g\frac{d\zeta}{yd} \end{aligned}\right\} \text{.......................(1)}$$

and—

$$\frac{d^2\zeta}{dx^2} + \frac{d^2\zeta}{dy^2} + \frac{\sigma^2 - 4n^2}{gh}\zeta = 0 \text{ ....(2)}$$

in which u, v are velocities of the relative motion, n the velocity of rotation, and ζ the elevation, h the depth of the water. The bounding walls are supposed to be $x = \pm\frac{\pi}{2}$, $y = \pm ly_1$. When n is evanescent, one of the principal vibrations is—

$$u = \cos x, v = 0 \text{ ....(3)}$$

and ζ is proportional to $\sin x$, which from (2) gives $\sigma^2 = gh$, when $n = 0$, and this is shown still to hold so long as n^2 is negligible. Then taking u as given in (3) and the corresponding ζ as a first approximation, he adds terms u', v', ζ' proportional to n, and on this principle works out a solution. In the case in which the rectangle is a square (3) has to be replaced by $u = \cos x$, $v = \pm i \cos y$. S. H. B.

1310. *Relation between the Mean Speed of Stellar Motion and the Velocity of Wave Propagation in a Universal Gaseous Medium bearing upon the Nature of Ether.* **L. d'Auria.** (Frank. Inst., Journ. 155. pp. 207–211, March, 1903.)—Kelvin has shown that ether if infinite cannot be subject to the law of gravitation, assuming that law to be accurate for infinite distances. If ether be so subject it must be finite, say a finite sphere in which the celestial bodies move. The present writer assumes it to be a gas, and calculates on that assumption the law of variation of density from the centre outwards, namely, that the density at distance z from the centre is proportional to $\frac{1}{z^2}$. And this leads to the conclusion that, all bodies moving in circular orbits round the centre, have the same velocity v_0, independent of the distance from the centre. Again, if u be the velocity of mean square in the supposed gas, $u^2 = \frac{3}{2}v_0^2$. If V be the velocity of propagation of a wave in the gas, $V^2 - \frac{1}{3}\gamma u^2$, γ being the ratio of the two elasticities, that is approximately 5/3. Referring to Kapteyn's investigations, he gives the value for v_0, 19·8 miles per second. Hence he concludes that V cannot be much greater than 17·6 miles per second. And the supposed gas cannot perform the primary duty of ether, which is, indeed, its *raison d'être*, namely, the transmission of light waves. Continuing the speculation, he concludes that the probable density of the supposed gas might be that of atmospheric at a distance of about 585,000 miles from the centre; that is an insignificant distance compared with stellar spaces. S. H. B.

1311. *Rigidity of Liquids.* **G. de Metz.** (Comptes Rendus, 136. pp. 604–606, March 9, 1908.)—Continuation of former experiments [see Abstract No. 50 (1903)]. In copal varnish the double refraction persists long enough (200 seconds) to enable T, the time of relaxation ($=(t' - t) \log e/(\log \Delta - \log \Delta')$, where Δ and Δ' are the differences of phase of the two rays at times t and t' seconds after the deformation) to be measured; and at temperatures 22°·90, 20°·75, 16°·40, 14°·60 and 10°·75 the values of T are 37·6, 44·7, 69·1, 81·5 and 145·2 seconds. Again, at 22°·2 the value of η is 4·80 grm./cm. sec.; and therefore since (Maxwell) the coefficient of rigidity of this liquid is $n = \eta/T$, $r = 0·12$ dyne/cm.^{2} at 22°·2. The rise of T as the temperature falls is related to the increase in the double refraction as the temperature falls. A. D.

1312. *On Shearing between Two Fluids.* **Hadamard.** (Comptes Rendus, 136. p. 545, March 2, 1908.)—The writer corrects an error into which he fell in the preceding memoir on this subject. [See Abstract No. 1151 (1908).] He there said that shears (glissements) cannot be formed at the surface of separation of two different fluids. That he now says is true only if the density be continuous, a condition which is realised in certain cases, and especially between two regions occupied by the same fluid. If the density be discontinuous the rise of acceleration need not be normal to the surface of discontinuity to make the pressure continuous. S. H. B.

1313. *On Aerodynamic Phenomena, and the Thermic Effects attending them.* **M. Smoluchowski.** (Acad. Sci. Cracovie, Bull. 3. pp. 148–182, March, 1908.)—The author discusses in section I. of this treatise the fundamental equations of hydrodynamics given by Stokes and others in so far as they are applicable to gases. In section II. he discusses the principle of similitude and its applications, giving several examples and references to previous authors. In section III. are discussed the thermic phenomena of currents; and in section IV. solutions are given of certain special problems of aerodynamics. S. H. B.

1314. *Viscosity of Liquid Phenol.* **O. Scarpa.** (N. Cimento, 5. pp. 117–130, Feb., 1908.)—Hagenbach's formula is used, which takes account of the *vis viva*: $\eta = \{(\pi P R^4 T/8VL) - (\delta . V/2^{10/3} \pi L T)\}$. In phenol the variations of friction with temperature are regular, without singular points until the phenol spontaneously crystallises and regains its fusing-point; but no formula yet proposed gives the relations between viscosity and temperature with exactness. A. D

1315. *On the Motion of Vitreous Media having Viscosity and with very slight Deformation.* **P. Duhem.** (Comptes Rendus, 136. pp. 592–595, March 9, 1908.)—The author resumes the discussion of vitreous media starting from the results obtained in his former notes on the subject, and using the same notation [see Abstracts Nos. 1145 and 1146 (1908)]. The equations of dilatation and the equation of rotation (which are here given) both belong to the same type of equations obtained by Stokes, involving differential coefficients of the third order. He concludes that, "If we consider small isothermic motions of a vitreous medium, having viscosity, and subject only to superficial forces, these small motions give rise to waves of an order $n \geqq 2$, with regard to the velocities u, v, w. These waves are generally of the order $n = 1$, with regard to N_i and T_i. During the whole motion they separate the same masses." S. H. B.

1316. *On Waves in a Vitreous Medium having Viscosity and very slightly Deformed.* **P. Duhem.** (Comptes Rendus, 136. pp. 733–735, March 23, 1908.)—This is in continuation of two former papers by the writer on vitreous media [see preceding Abstract]. He begins by enunciating the following Lemma: "If a wave continually separates the same two parts of the medium, and is of order ν with regard to the components of displacement $\xi\ \eta\ \zeta$, it is of order $\nu - 1$ with regard to the density ρ, and not less than ν with regard to the velocity $(u\ v\ w)$. On the other hand, if the wave is propagated throughout the medium, it is of order ν with regard to ρ, and generally also with regard to $(u\ v\ w)$." He then considers what waves of the second order for $(u\ v\ w)$ can persist in a medium of the kind supposed, and finds that U, V, W, the components of Hadamard's vector relative to $(u\ v\ w)$ must be each zero. There can then be no persistent wave of the second order unless $(u\ v\ w)$ is zero. The same proof holds for waves of higher order than the second. For waves of the first order with regard to $(u\ v\ w)$ the treatment requires some modification. He arrives at the following proposition: "If a vitreous medium, viscous and slightly deformed, is the seat of a persistent wave, that wave always separates the same two parts of the medium. If it is of order $n \geqq 1$ for $(u\ v\ w)$, it is of order $n - 1$ for the density, and for the six magnitudes ν_x, ν_y, ν_z, τ_x, τ_y, τ_z. If the medium is a conductor of heat, the wave is of order n with regard to τ the temperature. If a non-conductor, the wave is of order $n - 1$ with regard to τ. S. H. B.

1317. *Solid Bodies oscillating within Liquids.* **P. Bassi.** (N. Cimento, 5. pp. 109–117, Feb., 1908.)—The "critical distance"—at which attraction between a sphere oscillating in a liquid and another sphere floating at rest within the same passes into repulsion between these two spheres—increases with increase in the radius of one of the two spheres, be the density of the one at rest greater or less than that of the liquid; and it also increases with the density of the sphere at rest when the radii of the spheres are fixed; but when the sphere at rest is denser than the liquid this result is in disaccord with theory (Kelvin, Hicks, Bjerknes) and even when the sphere is less dense than the liquid, the results are qualitatively, but not quantitatively in accord with the theory. This disaccord should probably be attributed to vortices which the theory does not take into account. A. D.

1318. *Liquidogenic Theories of the Fluid State.* **E. Mathias.** (Comptes Rendus, 136. pp. 545–548, March 2, 1908.)—In the classical and commonly accepted theory, liquid in presence of saturated vapour constitutes a univariant system, *i.e.*, a system whose inner thermodynamic state is defined by a single variable. This theory cannot therefore explain any of the anomalies observed in the neighbourhood of the critical state, for it has no variable at its disposal which we might suppose liable to hysteretic lag, whereby such extra variability of the system might be explained. In de Heen's theory of the existence of liquidogenic and gasogenic molecules we have such an additional variable in the ratio *h* of these two classes of molecules. The special form of de Heen's theory leads, however, to the conclusion that *h* is a function not only of the temperature but also of the mean density of the whole system. This does not agree with the constancy of vapour pressure with varying ratio of liquid to vapour. The author points out that if we regard *h* as a universal function of the reduced temperature alone, a liquidogenic theory can be constructed which is in accordance with thermodynamics; it then possesses the advantage of being able to account for more phenomena than the classical theory. F. G. D.

1319. *Anomalous Gravitation in Instable Regions.* **F. de Montessus de Ballore.** (Comptes Rendus, 136. pp. 705–707, March 16, 1903.)—The author suggests a connection between earthquake disturbances, tectonic activity, and pendulum anomalies. The northern boundary districts of the Ganges Valley are frequently disturbed; the southern boundary districts are quiet. According to Burrard, a line joining Calcutta to Rajputana would divide a district of southerly deflections of the pendulum (places to the north of that line) from a district of northerly deflections (south of that line). This line also marked the extremities of the outrunners of rock, now covered by alluvium, which had been dislocated and were therefore exposed to destruction. [See also Abstract No. 385 (1903).] The case was clearer in Southern Russia. The triangle Kamienesk-Podolsk, Kazan, Astrakhan was, though quiet when compared to earthquake regions, instable in comparison to Northern Russia, and the boundary of this triangle partly coincided with the boundary of the ancient Hercynian chain, now disappeared (Bertrand), and with a line separating points of anomalous pendulum deflections (Collet and Stebnitzki). H. B.

1320. *Portable Mercury Tide Gauge.* **S. Nakamura.** (Mathematical and Physical Soc., Tokyo, 1. 15. pp. 123–126, 1901–1903.)—Two mercury cylinders are connected with one another by rubber tubing. The smaller vessel contains the float carrying the style. The space above the mercury in the larger one communicates through one branch of a T with the sea-water. The action depends upon the relative cross-sections of the two cylinders and the densities of the mercury and the sea-water. H. B.

1321. *Seiches of Lakes Biwa and Hakone.* **S. Nakamura** and **Y. Yoshida.** (Mathematical and Physical Soc., Tokyo, 1. 15. pp. 115–123, 1901–1903.)—Seiches having been noticed on Lake Hakone, a small lake 6·57 km. long, by Burton in 1891, the authors, on the suggestion of Nagaoka, studied this lake and Lake Biwa, the largest in Japan, 60 km. long, up to 17 km. wide, in 1901, with the aid of a Sarasin portable limnimeter. This preliminary account concerns chiefly Lake Hakone and the various ways employed for estimating its mean depth, about 25 m. The longest period observed, 15·4 min., agrees with a fundamental oscillation of the lake. H. B.

1322. *Seismograms of Distant Earthquakes.* **F. Omori.** (Mathematical and Physical Soc., Tokyo, 1. 16. pp. 148–165, 1901–1903.)—The author distinguishes first and second preliminary tremors, three phases of increasing intensity and three of decreasing intensity in the principal portion, and the end portion, and he discusses the amplitudes, periods and durations of these phases, as well as the transit velocities of the respective waves, and their probable paths, with regard to eighty-two distant earthquakes observed at Tokyo in 1900. The preliminary tremors seem to travel at some depth parallel to the surface with an average velocity of 11 km. per sec.; the third principal phase waves along the surface with a velocity of 3·8 km. per sec. H. B.

1323. *Biot's Hypothesis of the Height of the Atmosphere.* **W. de Fonvielle.** (Comptes Rendus, 136. pp. 835–837, March 30, 1903.)—Since aspiration through the thermometers fails in very rarefied strata, the temperatures at high altitudes are probably lower than those recorded. The author hence believes that in accordance with Biot's hypothesis, there may be liquefied and solidified air molecules above our gaseous atmosphere, analogous to the condensed and solidified water vapour of the upper strata. H. B.

1324. *Climatology of the Isthmus of Panama.* **H. L. Abbot.** (Monthly Weather Rev. 31. pp. 117–124, March, 1903.)—From observations conducted by the two canal companies during the greater portion of 26 years, it would appear that the climate of the Isthmus is very equable, the average temperatures of the hottest and coldest months being 81 and 78·3° F. The author discusses the influences of the sun's altitude, length of day, humidity, and of the adjacent seas, and gives also statistics concerning rainfall and barometer pressure for the Isthmus and various stations on the Continent and in the West Indies. H. B.

1325. *Diurnal Change in the Wind Direction.* **J. Hann.** (Akad. Wiss. Wien, Sitz. Ber. 111. 2a. pp. 1615–1711, Dec., 1902.)—On the earth's surface the wind as a rule turns with the sun; in the higher strata the wind deviates more and more to the right as we face the wind. This is due (Epsy-Köppen) to ascending currents and to the higher wind velocity in the upper strata, and should lead at higher levels to a weakening of the wind about noon and to a retrograde movement in the direction (Sprung). On mountain-tops, however, the wind also turns with the sun. The author shows that the relative deviation to the left of a vane at higher levels is compatible with a change in the wind direction, in the same sense, both below and above, and he calculates the hourly variations in wind force and direction for the altitudes 2 to 4 km. as dependent merely upon the sun's motion. His calculations concern different periods of observations for several years on the Sonnblick, Säntis, Obir, Pike's Peak, further, on the Eiffel Tower, at Vienna, and at Nukuss (in the desert, south of Lake Aral). The author finds a pronounced semi-diurnal oscillation in the wind components, connected probably with the barometric variations, and in accordance with Margules' air circulation in a rotating spheroid; the conclusions are confirmed by J. A. Brown's wind records from the Augustia Peak (Travancore Hills, Northern India). H. B.

1326. *Temperature Inversions in the Atmosphere.* **R. Assmann.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 14. pp. 298–306, March 12, 1903.)—Since January 1, 1903, balloons with registering apparatus have been sent up from

Berlin every day. Temperature inversions were observed, in the period August, 1902, to March, 1903, in 97 out of 205 cases, mostly between altitudes 200 and 1,500 m., never above 2,500 m.; the thickness of the warmer stratum is generally less than 500 m. The most remarkable case—13° warmer at 400 m., and 9° at 700 m. than on the surface—coincided with torrential rains in Spain and Italy, and the inversions seem to be observed at that edge of the anticyclonic area which is opposite a district of heavy rains. As ascending dry air cools by 1° for every 100 m., while ascending moist air cools by 0·4° only, owing to condensation, warm air would flow from a cyclone over to an anticyclone, and overlie the anticyclonic area. Reference is made to temperature inversions observed on the Brocken (1,150 m.), Belchen (Vosges, 1,400 m.), and Säntis (Switzerland, 2,500 m.). H. B.

1327. *Dust-Fall of Feb.* 22, 1903. **F. A. Forel.** (Comptes Rendus, 136. pp. 636–637, March 9, 1903.)—A yellow cloud was noticed on February 21 and 22 over Switzerland, France, the Tyrol, and South-west England and Wales, and dust-falls were reported also from different parts of Germany. The dust consisted of an impalpable yellow powder. At Lausanne the weather was exceptionally warm, and the author considers that the dust came from the Sahara. H. B.

1328. *Dust-Fall of Feb.* 22, 1903. **A. B. Chauveau.** (Comptes Rendus, 136. pp. 776–777; Remarks by **Mascart**, pp. 777–778, March 23, 1903.)—Dust-falls and dust-clouds were met with by ships off the West Coast of Africa between February 19 and 23. Similar dust-falls were reported from the Canary Islands during the middle and latter parts of February in 1888 and 1898. Mascart remarks that Chaves reports dust-falls on the Azores for February 20 to 22; the snow on Mount Pico, 2,274 m., was also yellow. [See also preceding Abstract.] H. B.

1329. *The "Bath Furnace" Meteorite.* **H. A. Ward.** (Amer. Journ. Sci. 15. pp. 316–319, April, 1903.)—The meteorite, now in the New York Museum, was seen at points 600 miles apart, struck a road, bounded away about 5 ft., and was found next morning at Bath Furnace, Kentucky. It is a stone, about 8 by 6 by 5 in., weighing 13 lbs., and consists, according to Merrill, essentially of olivine and pyroxene, with the usual metallic sprinklings and troilite; it was covered with a blackish opaque crust less than 0·5 mm. in thickness; the density is 3·45. As it fell on November 15, 1902, it is considered to belong to the Leonids. H. B.

1330. *Solar Radiation.* **H. Dufour.** (Comptes Rendus, 136. pp. 713–715, March 16, 1903.)—From observations made by Bührer at Clarens, on the Lake of Geneva, at an elevation of 380 m., and by the author at Lausanne, 520 m. above sea-level, it was found that the solar radiation was abnormally low during the months January to March, 1903. The average values for these three months have, during the period 1897 to 1902, been 0·79, 0·86, 0·89, whilst the values for the same months in 1903 were 0·68, 0·71, 0·70, showing hence no appreciable increase with the season. The observations were in both cases made with Crova actinometers, and are supported by observations with the photo-polarimeter of Cornu, particulars of which are not given. The author suggests that the dust thrown up by the West Indian volcanoes may absorb the sun-rays. H. B.

1331. *New Variable Star with an unusually Short Period.* **G. Müller** and **P. Kempf.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 7. pp. 178–183, Feb. 5, 1903.)—It was found that two measurements of the brightness of the 7·5 magnitude star B.D. + 56° 1400 ($\alpha = 9$h. 36m. 44s., $\delta = + 56° 24'·6$ [1900]), made for the Potsdam photometric catalogue, did not agree. Further measurements showed that the star was undoubtedly a variable and, further, that it possessed the extremely short period of about four hours. Based upon about 180 observations, the period was calculated to be 4h. 0m. 12·8s., with a possible error of ± 0·5 seconds. The brightness varies from about 8·6 to 7·9, and the authors suggest as a possible explanation that we have here two closely situated bodies of equal size and brightness which are very rapidly revolving round one another. In order to explain the small difference between the maximum and minimum, they suggest that the axis of rotation is not perpendicular to the sight-line, and that thus the bodies do not entirely eclipse one another. E. C. C. B.

1332. *Spectrum of the Comet* 1902 *b.* **A. de la Baume-Pluvinel.** (Comptes Rendus, 136. pp. 743–746, March 23, 1903.)—A photograph of the spectrum of this comet was obtained by means of an objective prism; the most important rays were at $\lambda = 472$ and $\lambda = 389$, and were evidently the heads of the hydrocarbon and cyanogen bands respectively. The plate also showed the other hydrocarbon bands, as well as some lines extending from $\lambda = 409·2$ to $\lambda = 400·0$, which do not belong to any of the carbon spectra. There was no evidence of any continuous spectrum, which shows that if there were any solar light reflected from the comet it must have been very small in amount. E. C. C. B.

REFERENCES.

1333. *Bending Load.* **F. Wittenbauer.** (Zeitschr. Vereines Deutsch. Ing. 47. pp. 245–247, Feb. 14, 1903.)—Previous investigations are extended to rods complexly loaded and with graded cross-section, without and with consideration of the proper weights of the rods. A generalisation of Euler's equations is given. [See Abstract No. 1812 (1902).] A. D.

1334. *Strength of Columns.* **A. Ostenfeld.** (Zeitschr. Vereines Deutsch. Ing. 46. pp. 1858–1861, Dec. 6, 1902.)—The formulæ proposed by Tetmajer are contrasted with those proposed by others. Numerical examples are given, and various coefficients for columns of T, C, Z and other sections are given. W. W. H. G.

1335. *Uniplanar Representation of Space, and its Application to Graphic Statics.* **B. Mayor.** (Comptes Rendus, 136. pp. 37–39, Jan. 5, 1903.)—An addition to the author's previous note on this subject in the same journal (135. p. 1318).

1336. *Lagrange's Dynamical Equations.* **G. Morera.** (Accad. Sci. Torino, Atti, 38. Nos. 4a. and 5a. pp. 57–70, 1902–3.)—This note is of purely mathematical interest. The writer's object is to prove that we may in the equations of Lagrange add to the kinetic energy T a certain function ϕ, which is the total differential of an arbitrary function of the parameters of position and of the time. Or more generally ϕ may be the product of an arbitrary multiplier into the total differential of an integral of the equations of condition, and these results are further generalised. S. H. B.

LIGHT.

1337. *Total Reflection of Light.* **W. Voigt.** (Gesell. Wiss. Göttingen, Nachr., Math.-Phys. Klasse, 3. pp. 121–125, 1903.)—The formulæ obtained by E. E. Hall, using the electromagnetic theory of light, for the passage of light through a thin layer of a medium at the first surface of which so-called total reflection of light takes place, are not in entire agreement with those obtained by Voigt, employing Kirchhoff's principle. The author ascribes the want of agreement to an error of calculation made by Hall, who calculated the amplitudes of the electric vibrations inside the system, but applied to the refractions at the first and last boundaries, not the formulæ holding for the amplitudes, but those for the intensities. Numbers are given to support this contention, which forms a reply to Hall's paper. [See Abstract No. 298 (1903).] G. E. A.

1338. *Refractive Index of Mineral Glasses.* **P. Tesch.** (Konink. Akad. Wetensch. Amsterdam, Versl. 11. pp. 710–713, March 28, 1903.)—The author indicates a method of smelting mineral powders, so as to form glasses, by means of a gas flame through which compressed oxygen is blown. A table is given showing the relation between the percentage in SiO_2 and the refractive index, the metal oxide present having a very small influence on the value of the latter, not exceeding the limits of possible errors. The relation thus found may be used in practice to readily determine the percentage of SiO_2 in slags, by means of the refractive index, within about 2 per cent. A. G.

1339. *Metallic Dispersion of Light.* **R. S. Minor.** (Ann. d. Physik, 10. 3. pp. 581–622, Feb., 1903. Extract from the Göttinger Inaugural Dissertation.) —Voigt's photographic method [see Abstract No. 1060 (1901)], which is especially adapted for experiments with ultra-violet light, is employed to determine the optical constants of steel, cobalt, copper, and silver. Steel and cobalt exhibit anomalous dispersion, and their curves of dispersion are very similar except that for $\lambda = 326\,\mu\mu$ the refractive index of steel has a feeble minimum. Copper displays normal dispersion, whilst silver is anomalous for rays of wave-length between 226 $\mu\mu$ and 280 $\mu\mu$, and also in the visible part of the spectrum. The index for silver varies between 1·57 and 0·155, and the reflecting power of silver for rays between 307 $\mu\mu$ and 326 $\mu\mu$ is less than 10 per cent. [See also Abstract No. 452 (1902).] The paper is illustrated by many tables and curves, and the theory of the method is explained. G. E. A.

1340. *Refraction and Dispersion of Light in the Chromosphere.* **A. Schmidt.** (Phys. Zeitschr. 4. pp. 282–285, Feb. 15, 1903.)—The heavenly bodies may be divided into two classes; in the case of the second of these, horizontal rays at the surface of the body are so strongly bent by refraction that their path is more curved than the surface of the body itself. This refractive effect becomes smaller the further away from the surface the path of the ray lies, until we reach the critical sphere at which the curvature of a horizontal ray becomes equal to that of a circle described round the centre of the body; the ray therefore passes all round the body and returns on itself. Outside the critical sphere the rays behave as the horizontal rays in the case of bodies of the first class. Considering now a point on the photosphere of the sun, which lies within the critical sphere, it is evident that only a fraction of the emitted light can escape into space. Only those rays can escape which make with the perpendicular to the surface angles less than a certain critical value, otherwise they will be refracted so that their paths lie within the critical sphere. This is perfectly analogous with the case of a point source of light under water; in this case only those rays escape from the water surface which strike it at a smaller angle than the critical angle. The pencil of rays, however, which are emitted from the water subtends an angle of 180°, and the same is true in the case of the sun. Evidently, therefore, the rays cannot possess the same brightness as the original rays from the source, and the decrease of brightness must be greater for the more refrangible rays. Furthermore, the outer rays of the beam must suffer a greater decrease in brightness than the central rays. It is evident from the above that the apparent diameter of the sun is very different from the real diameter, and all estimations of the sun's temperature by Stefan's or Wien's law must be erroneous. Now we have measurements by Vogel of the relative brightness of the sun's disc compared with that of the central portion, which is put at 100; these values are given in the following table:—

Distance from Centre of Disc.	Intensity of Spectral Regions.					
	I. $\lambda=405-\lambda=412$.	II. $\lambda=440-\lambda=446$.	III. $\lambda=967-473$.	IV. $\lambda=510-\lambda=515$.	V. $\lambda=573-585$.	VI. $\lambda=658-666$.
0·0	100	100	100	100	100	100
0·1	99·6	99·7	99·7	99·7	99·8	99·9
0·2	98·5	98·7	98·8	98·7	99·2	99·5
0·3	96·3	96·8	97·2	96·0	98·2	98·9
0·4	93·4	94·1	94·7	94·3	96·7	98·0
0·5	88·7	90·2	91·3	90·7	94·5	96·7
0·6	82·4	84·9	87·0	86·2	90·9	94·8
0·7	74·4	77·8	80·8	80·0	84·5	91·0
0·8	63·7	67·0	71·7	70·9	74·6	84·3
0·9	47·7	50·2	57·6	56·6	59·0	71·0
1·0	13·0	14·0	16·0	16·0	25·0	30·0

This table shows that we must be dealing with a phenomenon of refraction and dispersion and not one of absorption. A very striking inversion is shown in the fourth column of the intensities. We may consider an elementary geometrical treatment of the problem, remembering that the results can only be true for points near the sun's surface. Let a horizontal incandescent surface be covered by a transparent refracting and fluid medium, and let the rays emanating from one point of the surface be considered. Out of the beam of rays escaping from the liquid surface let a hollow cone be cut whose inner and outer surfaces are formed by rays which make the angles β and $\beta+\delta\beta$ with the perpendicular. By refraction these are changed to the angles α and $\alpha+\delta\alpha$. Without the refracting medium a plane section of the hollow cone would be a ring with an inner radius, $a \tan\beta$, but by refraction this is changed to $a \tan a$. A double distortion is thus produced, first in the spherical radius in the ratio $\frac{\partial a}{\partial \beta}$, and secondly a circular distortion perpendicular to the first in the ratio $\frac{\tan a}{\tan \beta}$. The brightness is thus diminished by both effects thus: $H = H_1 \frac{\tan \beta \partial \beta}{\tan a da} = H_1 \frac{\cos^2 a}{\mu^2 \cos^2 \beta}$ since $\sin a = \mu \sin \beta$ and $\cos a \partial a = \mu \cos \beta \partial \beta$. In the centre, therefore, where $d = 0$, $H_0 = H_1 \frac{1}{\mu^2}$ and at the extreme edge $H = 0$ when $a = 90°$. If now a sphere be substituted for the plane then a does no longer $= 90°$ at the edge, but is smaller the higher the atmosphere round the sphere. In the case of the sun let ϕ be the angular distance of a point on the photosphere from the centre of the disc β, and a as before the angles of emergence and refraction, r the apparent sun's radius and e the distance of the sun from the earth; then if ϕ_1 be the angular semidiameter of the sun we have $\sin \phi_1 = \frac{r}{e}$ and further $\sin \phi = \frac{r}{e} \sin a$. It follows that $\sin a = \frac{\sin \phi}{\sin \phi_1}$ or more simply $\sin a = \frac{\phi}{\phi_1}$. Now $\frac{\phi}{\phi_1}$ represents the values given in the first column of Vogel's table given above, so that μ may be at once calculated. From the equations for H given above—

$$H = H_0 \frac{\cos^2 a}{\cos^2 \beta} = H_0 \frac{\cos^2 a}{1 - \frac{\sin^2 a}{\mu^2}}$$

whence—

$$\mu = \frac{\sin a}{\sqrt{1 - \frac{H_0}{H} \cos^2 a}}$$

From Vogel's table the values of $\frac{H_0}{H}$ can be obtained and also the values of $\sin a$. This was done, and the author gives the values of μ for the six spectral regions. The only trustworthy results were obtained for $\sin a = 0{\cdot}3$, $0{\cdot}4$, $0{\cdot}5$, and $0{\cdot}6$; in the other cases the errors due to the approximate nature of the calculation were too pronounced. The mean values are as follows:—

	I.	II.	III.	IV.	V.	VI.
$\mu =$	1·2705	1·2184	1·1821	1·2027	1·1039	1·0568

In conclusion the author considers that in the neighbourhood of the critical sphere there must be an extraordinarily light gas present in the sun's atmosphere; this he considers may be coronium, which shows the green line at $\lambda = 531{\cdot}6\ \mu\mu$.
E. C. C. B.

1341. *Theory of the Connection between the Energy of Light Introduced into a System and the Chemical, Thermal, Mechanical Energy, &c., of the same.* **M. Wilderman.** (Phil. Mag. 5. pp. 208–226, Feb., 1903.)—The author assumes that the portion of the light-energy absorbed by the system is converted not only into thermal and chemical energy, but also into an energy *sui generis* which he terms *light-kinetic* energy, regarding it as kinetic energy stored up in the atomic motions and derived from the "impulses of the ether waves." Employing Gibbs's notation, the author endeavours to express the idea thermodynamically, and assumes that the chemical potential of each component of an illuminated system breaks up into two potentials, a "light-modified" chemical potential and a "light-kinetic" potential. These assumptions lead to the conclusion that the equilibrium-point will be shifted on illumination. The view taken by the author is therefore that a definite amount of energy is taken up, and that it is the presence of this energy, modifying the equilibrium of the system, which causes or influences photochemical reactions. The author concludes, therefore, that such reactions do not occur in the "dark," and neglects any possible catalytic action of light. Finally a theorem analogous to van't Hoff's theorem of mobile equilibrium, but applying to the action of light, is propounded. According to this theorem the equilibrium will tend to shift on increase of illumination towards that system which absorbs most light. With respect to the above paper it may be remarked that (*a*) in the "proof" given that the heat of a chemical reaction will be different in an illuminated system, the conclusion is virtually assumed in the major premise; (*b*) the distinction drawn between a "light-kinetic" potential and a chemical potential is foreign to the thermodynamical reasoning underlying Gibbs's equations; (*c*) if the author's theorem concerning the direction of the equilibrium-shift on increase of illumination be true, why does a mixture of $Cl_2 + H_2$ tend to pass into HCl on illumination? (*d*) the author makes no reference to the important work of Luther bearing on the same subject. F. G. D.

1342. *General Theory of Translucidity.* **J. Boussinesq.** (Comptes Rendus, 136. pp. 581–587, March 9, 1903.)—By a translucid medium is meant one which is very slightly opaque for distances comparable with the wavelength. Analytically the treatment of a wave passing through such a medium involves the introduction of new terms into the equations of motion, namely, in addition to $a\xi''$, $b\eta''$, $c\zeta''$, we shall have the first differentials according to the time of the displacements ξ, η, ζ, namely, $a'\xi'$, $b'\eta'$, $c'\zeta'$. In the perfectly transparent medium the expression for ξ, η, ζ, contain the exponential factor $e^{-k(t-lx-my-nz)\sqrt{-1}}$, as in the writer's former papers. The new terms will then have the same form as the old ones in $\frac{d^2\xi}{dt^2}$, &c., but with small coefficients a', b', &c., and with the factor $\frac{1}{k\sqrt{-1}}$, or $-\frac{1}{k}\sqrt{-1}$. The coefficients a, b, &c., of the transparent medium become $a\left(1+\frac{a^2a'}{k}\sqrt{-1}\right)$ &c., or, as he writes it, $a+\delta A$, &c. If in the transparent medium we have $F(a, b, l\ m\ n)=0$, in the translucid medium we shall have correspondingly, $F(A, B, \&c., L\ M\ N)=0$; and L, M, N will have respectively, in addition to their real part, a small imaginary part δL, δM, δN, due to the increases δA, δB, δC of $a\ b\ c$. If f denote the coefficient of extinction treated in the former papers—

$$\delta L = -\frac{f\sqrt{-1}}{k}\cos\alpha', \quad \delta M = -\frac{f\sqrt{-1}}{k}\cos\beta', \quad \delta N = -\frac{f\sqrt{-1}}{k}\cos\gamma',$$

$\alpha'\ \beta'\ \gamma'$ being the angles made with the axis by the normal to the planes of equal amplitude. Hence he finds—

$$f = \frac{\frac{dF}{da}a^2a' + \frac{dF}{db}b^2b' + \&c.}{\frac{dF}{dl}\cos\alpha' + \frac{dF}{dm}\cos\beta' + \frac{dF}{dn}\cos\gamma'},$$

that is f is proportional to the cosine of the angle, V″, made by the normal to the wave with the normal to the planes of equal amplitude. Then if L′, M′, N′ be the coefficients of the exponential $e^{-k(t-lx-my-nz)\sqrt{-1}}$ in the expressions for ξ, η, ζ, L′, M′, N′ are connected by the linear equations $\phi L' + \chi M' + \psi N' = 0$; $\phi_1 L' + \chi_1 M' + \psi_1 N' = 0$; $\phi_2 L' + \chi_2 M' + \psi_2 N' = 0$; in which ϕ, χ, ψ denote known functions; and λ, μ, ν, being quantities which may be substituted for L′, M′, N′ in these equations, are taken as types. In the translucid medium L′, M′, N′ have ceased to be exactly proportional to the λ, μ, ν of the transparent medium. Let λ', μ', ν' be so proportional. Then he finds to a near approximation—

$$f = \frac{\omega}{\cos V'} \frac{\lambda\lambda' a' + \mu\mu' b' + \nu\nu' c'}{\lambda\lambda' + \mu\mu' + \nu\nu'};$$

where ω denotes the velocity of propagation; and further to a near approximation—

$$f = \frac{\omega}{\cos V''} \frac{a'\overline{\xi^2} + b'\overline{\eta^2} + c'\overline{\zeta^2}}{\overline{\xi^2} + \overline{\eta^2} + \overline{\zeta^2}} = \frac{\omega}{\cos V''} \frac{a'\overline{\xi'^2} + b'\overline{\eta'^2} + c'\overline{\zeta'^2}}{\overline{\xi'^2} + \overline{\eta'^2} + \overline{\zeta'^2}},$$

where ξ' stands for $\frac{d\xi}{dt}$, &c., and the bar denotes mean values taken over a complete period. This, he says, is the generalisation of equations (17) and (20) of the last memoir (p. 530), and the answer to the question propounded in the Note of February 2, 1903 (p. 272). S. H. B.

1343. *Fundamental Equations of the Electromagnetic Theory of Light for Bodies in Motion.* **F. Hasenöhrl.** (Akad. Wiss. Wien, Sitz. Ber. 111. 2a. pp. 1525–1548, Oct. and Nov., 1902.)—The author deduces the equations without assuming the existence of ions. His method is similar to that of Boltzmann for establishing Maxwell's equations for bodies at rest. The ether of free space is supposed to penetrate matter and not to take part in its motion, while the alteration in the ether, which conditions the difference of electric phenomena in ether and in matter, moves with matter. The author's results are essentially identical with those of Lorentz. W. S.

1344. *Light Intensity in Prismatic Telescopes.* **H. Krüss.** (Zeitschr. Instrumentenk. 23. pp. 8–19, Jan., 1903.)—The numbers given by many makers of prismatic telescopes for the brightness of the image are obtained from: size of objective aperture ÷ square of magnification. The actual intensity of the light in a telescope, however, not only depends on the geometrical relations, but is influenced considerably by the loss of light in the optical parts of the instrument, by the construction, the kinds of glass employed and the preparation of their surfaces. The intensity of the light which has passed through a prismatic telescope was measured by photometer, light from a lamp being passed through a lens and a collimator, then by parallel rays into the telescope, another lens producing, when necessary, an enlarged image on the photometer screen. The total amount of light passing through different telescopes is compared, and the loss of light in the telescope is next obtained by separating the binocular into two parts, placing these end to end with the eyepieces together, and measuring the intensity of the light which passes through these two parts. For two binoculars, the amounts of light lost were 41 and 49 per cent. respectively; calculation shows that the loss due to reflection and absorption in the glass is of this order. [See also Abstract No. 784 (1903).] G. E. A.

1345. *Absorption of Light.* **J. Boussinesq.** (Comptes Rendus, 136. pp. 530–535, March 2, 1903.)—Absorption of light (1) by a body naturally heterotropic, to which a magnetic field gives power of rotation (2) by an isotropic body which in the same field becomes double refracting and dissymetric. This is in continuation of the author's paper on the absorption of light, February 2, 1903; and the same notation is employed as in that paper. It was pointed out in that paper that the absorption of light in translucid bodies (*i.e.*, those which are slightly opaque for thicknesses comparable with the wave-length) and also the magnetic rotation of the plane of polarisation, could be explained by assuming in addition to the "principal resistance" of ether, whose components are linear in ξ'', η'', ζ'', two other resistances, one whose components are $a'\xi'$, $b'\eta'$, $c'\zeta'$, derived from a dissipation function and called frictional resistance, and another having three components, $f\eta' - e\zeta$, $-f\xi' + d\zeta$, $e\xi' - d\eta'$, to which the magnetic rotation is due. The former note dealt only with the special case in which the principal axes of the ether resistance and of the frictional resistance coincide, whence he derived the equations of motion (2) of that note. In the present paper he starts from equation (8) of the last note, and proceeds to find expressions for the coefficient of absorption, f, in the several cases respectively. The coefficients a', b', c' of the frictional resistance, and the components d, e, f expressing the magnetic field are supposed to be very small. [See also Abstract No. 1001 (1903).] S. H. B.

1346. *Zonal Aberration and Astigmatism.* **K. Strehl.** (Zeitschr. Instrumentenk. 23. pp. 6–8, Jan., 1903.)—The author has found that zonal aberration due to mechanical defects in the telescope objective is a great cause of bad definition. The defect may be located by the eye or by photography, the objective being covered with a screen except the faulty part, which is left in the middle of an opening of about one-third of the diameter of the whole aperture. The image of a luminous point, thus formed, is astigmatic (cross-shaped). An expression for the numerical measure of the astigmatism is obtained, and two particular cases are distinguished and considered. [See also Abstracts Nos. 66 (1901) and 205 (1903).] G. E. A.

1347. *Reflection from Walls of Photometer Room.* **F. J. Rogers.** (Phys. Rev. 16. pp. 166–169, March, 1903.)—The statement that the intensity of illumination varies inversely as the square of the distance from the source, will obviously only be capable of experimental proof if reflected light is carefully excluded. The author shows that irregular reflection of one kind and another, even under favourable circumstances, will make the above law only approximately true, and describes experiments in his photometer room, showing that reflection caused, in the cases under consideration, the relation between illumination and distance to be expressed by a law such as $I = kD^n$, where n varies between $-1{\cdot}85$, and $-1{\cdot}92$, and k is a constant. W. H. S.

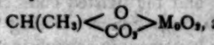
1348. *Optical Resonance.* **J. Kossonogoff.** (Phys. Zeitschr. 4. pp. 208–209, Jan. 1, and pp. 258–261, Feb. 1, 1903. From the Physical Laboratory at Kiew, Dec. 15, 1902.)—Working on the same lines as R. W. Wood, and at about the same time, the author also found that films of small metallic particles possess optically resonant properties. [See Abstract No. 1659 (1902).] The resonance is caused by particles of the size of the wave-length of light, which are visible in a microscope. When the particles are immersed in a dielectric of greater inductive capacity than air, the electromagnetic behaviour of the particles undergoes a change, and they can then reflect longer waves than before. From each of the metals investigated, viz., Au, Pt, Ag and Cu, a film of any colour can be made by chemical, mechanical, or electrical means. The second part of the paper deals with measurements of the particles on the wing-scales of butterflies. The diameter of the particles as measured in nine different species were as follows:—Red, 0·796 μ; carmine, 0·6812; bright red, 0·6643; orange, 0·6162; greenish-yellow, 0·5538; green, 0·5070; violet, 0·4095; black, 0·35696; black, 0·3598 μ. The particles are thus of the same size as the corresponding wave-lengths. G. E. A.

1349. *Use of Contour Integration in the Problem of Diffraction by a Wedge of any Angle.* **H. S. Carslaw.** (Phil. Mag. 5. pp. 374–379, March, 1903.)—Macdonald in his Adams Prize essay has discussed the two-dimensional problem, where the boundary is formed by two planes, including an angle α, deducing his result by means of a general theorem proved earlier in the essay. The author gives another demonstration, using the method of contour integrals. His result agrees with Macdonald's. W. S.

1350. *Demonstration of Newton's Colours by Transmitted Light.* **H. N. Davis.** (Amer. Journ. Sci. 15. pp. 224–226, March, 1903. A lecture experiment suggested by Professor Barus.)—The effects, which are on a large scale, are described as sometimes "most magnificent, even rivalling the best of our autumn sunsets." A number of wire rings of the same size are mounted in parallel planes and dipped together in a soap solution, their planes being kept perpendicular to its surface. Light is passed through these, and can be caught on a sheet of paper, showing the desired phenomenon. For class demonstration the paper is replaced by a good lens, and the colours projected, on a large scale, upon a screen. Since each film, under the action of gravity, is a very thin wedge, the colours are in horizontal bands, which move slowly down across the field as the films evaporate, to be succeeded by other bands of lower orders. The rings, which are about 5·5 cm. in diameter, are made of galvanised iron wire ($d = 1·2$ mm.), and formed upon a gauge, the ends being twisted together. The rings are strung, 1 cm. apart, on three notched rods, and the twisted ends clamped between two pieces of wood. From 15 to 30 rings suffice. During the course of this experiment, before the films have become thin enough to show colours, certain other phenomena of a circulatory character are very noticeable. These may be studied most easily in the projected image of a single film held in the focus of the lens, a narrow trough being raised so as to submerge the ring when necessary. The moving images are of two kinds, one corresponding to air-bubbles running up at the sides, the other to drops running down through the middle. These sets are of opposite colours, the latter being the more interesting. An empirical formula was found for the velocity of the drops, $v^2 = 2p(y - q)$, y being the distance from the top of the ring, and p and q functions of the time. These drops are not mere bulges, but are little concentrated globules floating in the liquid, having a surface tension with respect not only to air, but to the rest of the solution. The author suggests that further study of such descending masses may throw light on problems of surface viscosity. A. E.

1351. *Theory of Photographic Processes.* **G. Jäger.** (Akad. Wiss. Wien, Sitz. Ber. 111. 2a. pp. 1132–1143, July, 1902.)—After making certain assumptions and treating these mathematically, the author concludes that if we use a dilute developer and do not develop too long, the blackening (*i.e.*, the proportion of light absorbed by the negative) is proportional to the concentration of the developer, to the quantity of "active" AgBr (rendered developable by the action of light), and to the time of development; but that with prolonged development it tends to become proportional to the square root of the quantity of active AgBr. Further, that it is only concentrated developers which can reduce all the active AgBr. A. D.

1352. *Photogrammetry of Clouds.* **E. Doležal.** (Akad. Wiss. Wien, Sitz. Ber. 111. 2a. pp. 788–813, May and June, 1902.)—A mathematical discussion of the problem and photographic methods for measuring cloud-data by conjoining the cloud itself with its image in smooth water. A. D.

1353. *Influence of Molybdenum and Tungsten Trioxides on the Specific Rotations of* l-*Lactic Acid and Potassium* l-*Lactate.* **G. G. Henderson** and **J. Prentice.** (Chem. Soc., Journ. 83. and 84. pp. 259–267, March, 1903.)—Aqueous solutions of potassium *l*-lactate dissolve molybdenium trioxide readily, and tungsten trioxide to a somewhat less extent. In either case the specific rotation, $[\alpha]_D$, of the solution increases with the amount of the trioxide present, and attains maximum values at 20° of + 22·69° with molybdenum trioxide, and + 10·80° with tungsten trioxide; the maximum value is obtained when 1 mol. of the trioxide is present for every 2 mols. of the lactate, the solutions thus formed being practically saturated with respect to the trioxide. These results indicate the formation of a double lactate according to the equation: $2C_3H_5O_3K + RO_3 = RO_2(C_3H_4O_3K)_2 + H_2O$; R representing Mo or W. Sodium molybdate and tungstate dissolve readily in aqueous *l*-lactic acid solutions, the maximum values for $[\alpha]^D$ at 20° being + 21·15° and + 9·9° in the two cases, and these are obtained when the proportions are 1 mol. of sodium salt to 2 mols. of the acid. In this case the reaction appears to be: $2C_3H_6O_3 + Na_2RO_4 = RO_2(C_3H_4O_3Na)_2 + 2H_2O$. The trioxide of molybdenum, but not that of tungsten, is also readily dissolved by aqueous *l*-lactic acid, but the solution must be prepared in the cold and in the dark, as the compound formed is decomposed by heat or daylight. When 1 mol. of the oxide is present for every mol. of the acid, the $[\alpha]_D$ at 20° attains a maximum value of + 24·78°. The compound formed is either $CH(CH_3)(CO_2H)O.MoO_2OH$, or more probably  $CH(CH_3)<\genfrac{}{}{0pt}{}{O}{CO_2}>MoO_2$, and is so sensitive to light that paper soaked in it and dried in the dark yields a very good positive when exposed to light under a negative. T. H. P.

1354. *Magnetic Double Refraction.* **A. Schmauss.** (Ann. d. Physik, 10. 3. pp. 658–660, Feb., 1903.)—In repeating Majorana's experiments [see Abstract No. 1844 (1902)] it was found that Bravais' iron solution in a strong magnetic field, instead of being a troubled medium, developed, under homogeneous polarised light, apparent dark streaks which followed the lines of force, with clear bright yellow liquid between. In varying fields these streaks wander in the liquid. Looking along lines of force no streaks are visible, and the liquid is dark or clear according to the distance the light has travelled in it; and with white light colour-phenomena are produced, which are described. A. D.

1355. *Improved Polarising Vertical Illuminator.* **J. Joly.** (Roy. Dublin Soc., Proc. 10. pp. 1–5, March 9, 1903.)—Immediately above the objective in the microscope tube is placed an additional tube having a side aperture which allows a beam of light to fall on a small cover-glass placed at 88¼° to the optical axis of the instrument and to be then reflected along the axis through the objective to the specimen. The latter is placed on a piece of speculum metal which reflects the light. The method, besides rendering the use of a polariser unnecessary, also utilises a doubled thickness of section, and consequently an increased range of colour-variation in the crystals is obtained.

G. E. A.

1356. *Optical Rotating Power of Camphor Dissolved in Inorganic Solvents.* **H. Schlundt.** (Journ. Phys. Chem. 7. pp. 194–206, March, 1903.)—Previous investigators have confined their attention to organic solvents. Comparison of their results with the author's, shows that the regularities observed for the rotation of camphor when dissolved in organic solvents, obtain also for solutions in inorganic solvents: (1) The specific rotation increases with the concentration; (2) the rotation increases with rise of temperature; (3) the values obtained for the specific rotation of pure camphor at 20° confirm the value 55·4 ± 0·4 first assigned to it by Landolt; (4) for solutions of the same concentration, the specific rotation follows the order of the molecular weights of the solvents, increasing with increase of molecular weight. Certain of the results show that no abrupt change occurs in the rotation as the boiling-point of the solvent is passed. The temperature coefficient remains positive, but its value is less at the higher temperatures. The following values were deduced for the specific rotation of pure camphor with sodium light:—

Solvent.	Temp.	$[\alpha]_D$
Carbon disulphide	20°	55·41
Sulphur dioxide	20°	55·64
Phosphorus trichloride.....................	20°	54·8
" "	40°	56·4
" "	0°	58·1

$[\alpha]^t_D$ was calculated from the usual formula $[\alpha]^t_D = \frac{\alpha^t_D \times 100}{l \times p \times d}$ in which α^t_D represents the observed rotation at the temperature $t°$, l the length of the tube in dcm., p the number of grams of camphor in 100 grams of solution, and d the density of the solution at temperature $t°$. The polariscope used in the experiments was a half-shadow instrument provided with a Lippick polariser. Measurements were also made for the solvent sulphur monochloride, but as the light used was of different wave-length (the C line), they are not included in the above comparisons.

A. E.

1357. *Ultra-violet Reflecting Power of Selenium, Cyanine, and Glass.* **P. G. Nutting.** (Phys. Rev. 16. pp. 129–139, March, 1903.)—By a polarisation method, in which light bands in the spectrum image given by one source of light are made exactly to overlap the dark bands in the image from the other source, adjustments being made until the photograph of the spectrum shows no bands, the limit of error in photometry can be reduced to one-hundredth of 1 per cent. In selenium the observed reflecting power increases abruptly from a low value in the red to a maximum in the yellow, falls off slightly towards the violet, and then more rapidly in the ultra-violet. In cyanine (Kahlbaum's diamyl iodide, $C_{29}H_{35}N_2I$, prepared by casting) the reflecting power rises in the red to a maximum (14 per cent.) in the yellow, falls to 1·26 per cent. in the green and then gradually increases to a nearly constant value of 6·8 per cent. in the ultra-violet; but on exposure of the cyanine to light (which turns it from brassy yellow to plum colour or steely blue-black, according to the exposure, this action being mainly due to yellow rays), we have an almost constant reflecting power of 6·5 per cent. throughout. The anomalous dispersion has then disappeared, and the absorptive and refractive indices are greatly altered. In glass there is no abrupt increase in the reflecting power where the high absorptive power for ultra-violet rays begins, and there is no indication of any anomalous dispersion in that region. [See also Abstract No. 285 (1902).] A. D.

1358. *A New Series of Lines in the Spectrum of Magnesium.* **A. Fowler.** (Roy. Soc., Proc. 71. pp. 419–420, April 30, 1903.)—Four lines obtained in the spectrum of magnesium, when the arc is formed between poles of the metal, at λ = 4511·4, λ = 4251·0, λ = 4106·8, and λ = 4018·8 appear to form an associated series with the strong series of single lines described by Rydberg. This latter series does not obey Rydberg's general equation—

$$n = n_\infty + \frac{a}{(m+\mu)^2}$$

but was found by him to be expressed by a combination of his and Kayser and Runge's formulæ: $n = n_\infty + \frac{b}{(m+\mu)^2} + \frac{c}{(m+\mu)^4}$, where n is the oscillation frequency, n_∞, μ, b, and c are constants, and m has the values 3, 4, 5, &c. The four new lines given by the author can be expressed by this formula using different values of the constants. An alternative formula for the two series is the following:—

$$n = n_\infty - \frac{C}{(m+\mu)^2 - m_0}$$

The convergence-frequencies, n_∞, of the two series are evidently equal. By calculation from the formula the two first lines of the new series are obtained at λ = 5065 and λ = 6674·5; the first of these no doubt is the line at λ = 5067, but the second has not been observed. E. C. C. B.

1359. *A New Connection between Arc and Spark Spectra.* **J. Hartmann.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 12. pp. 234–244, Feb. 26, 1903.)—An account of some further experiments upon the relative behaviour of the arc and spark lines in the spectrum of magnesium [see Abstract No. 1185 (1903).] The observations chiefly deal with the spark line λ = 4481. The relative brightness of this line in the arc spectrum is given as very different by different observers, and the author finds that this is due to the conditions of the arc. For example, when the arc is formed between carbon rods cored with magnesium, this line is very faint, and when the arc is formed between pure magnesium poles the line is at times extremely bright. In the latter case of the arc between magnesium poles the line is much weaker in the centre of the arc than it is close up against the electrodes; further, the relative brightness of the line depends upon the current used, for with a current of 8 amperes at 29 volts potential it was extremely faint, while with a current of only 0·4 ampere the line was ten times as bright as the neighbouring arc line at λ = 4352. This emphasises the conclusion drawn in the previous paper that the spark lines are not due to a greater temperature. A surrounding atmosphere of hydrogen also intensified the spark lines; in one instance, with the arc between magnesium poles in hydrogen, the line at λ = 4481 was the brightest line in the whole spectrum, while the principal arc lines had almost disappeared. This is of considerable importance in connection with the spectra of the stars of the first type. E. C. C. B.

1360. *Position of Radium in the Periodic System as Determined by its Spectrum.* **C. Runge** and **J. Precht.** (Phys. Zeitschr. 4. pp. 285–287, Feb. 15, 1903. From the Physikalisches Institut der technischen Hochschule, Hannover.)—By means of their behaviour in the magnetic field the authors selected the lines in the radium spectrum, which form the first pair in the principal and the first and second subordinate series respectively. These lines correspond exactly to the similar lines in the spectra of magnesium, calcium, strontium, and barium. It is well known that the frequency differences of all the pairs of the two subordinate series and the first pair of the principal series are all equal. Now this frequency difference is nearly proportional to the square root of the atomic weight for the elements of one chemical family. This is not strictly true, and the authors state the law as follows: The atomic weight is proportional to a power of the frequency difference, or the logarithms of the atomic weights are a linear function of the logarithms of the frequency differences. These frequency differences for magnesium, calcium, strontium, and barium are 91·7, 223, 801 and 1691; on plotting the logarithms of these numbers against the logarithms of the atomic weights a straight line is drawn through the points and is extrapolated to find the atomic weight of radium, taking its frequency difference as 4858·5. In this way the atomic weight is found to be 257·8.

This value does not deserve more consideration than that experimentally determined by Mme. Curie as 225, but it must be remembered that barium and radium bromides are isomorphous, and therefore very difficult of separation. An incomplete separation would tend to lower the atomic weights as determined by chemical means. The value 225, on the other hand, fits in with the periodic system much better than 257·8. E. C. C. B.

1361. *Band Spectrum of Nitrogen at Atmospheric Pressure.* **A. Hagenbach** and **H. Konen.** (Phys. Zeitschr. 4. pp. 227–229, Jan. 15, 1903.)—The authors have examined the spectrum of nitrogen as it appears in the spark between metal electrodes in air at atmospheric pressure, and they find that both the positive and negative band spectra are to be seen. A small Rowland concave grating was used and sparks from a large coil were passed between electrodes of many different metals; Leyden jars and self-induction coils could be intercalated if desired. The fact that the two banded spectra are visible is not new, but certain very striking changes in the relative intensities of individual bands were also observed. For example, the negative band spectrum is, on the whole, relatively brighter at atmospheric pressure than it is in a vacuum tube containing air at 4 mm. pressure; the head of one band of this spectrum, however, is brighter at reduced pressures than in the spark, while a part of the band is much weaker. Again, the first series of lines in each band of the positive spectrum is missing in the spark, while the second and third series are strong. The authors attempt no explanation of these interesting changes but are continuing the experiments. E. C. C. B.

1362. *Analysis of Spectrum Lines by Means of the Interference Fringes produced by Plane Parallel Plates.* **O. Lummer** and **E. Gehrcke.** (Ann.

d. Physik, 10. 3. pp. 457–477, Feb., 1903. Communication from the Physikalisch-Technischen Reichsanstalt.)—The greater part of this paper deals with the theory of the fringes produced by means of plane-parallel glass plates; the apparatus has been already described [see Abstract No. 674 (1902)]. As in the previous paper, the results of the examination of the lines of the mercury spectrum are given. The authors describe some results they have more recently obtained with certain metallic spectra. In general the lines of the spark spectra of metals are far too broad and non-homogeneous for examination in this apparatus. The cadmium lines, however, gave very good results, and it was found that the red line has three, the green line two, and the blue line three comparisons. The authors point out that under these circumstances the wave-lengths obtained for these and other similar lines should depend upon the method employed. The centre of a system of at least four components must appear different with an interference apparatus from what it does with a diffraction grating; in the former case, where very closely situated spectra of high orders are observed, the fringes due to different components can very easily be superimposed and confused with one another, while in the case of a Rowland grating where the lower orders are observed such a condition cannot occur. A dangerous source of error, therefore, is to be found in interference measurements. The differences between Fabry and Perot's measurements and those of Rowland can thus be explained as having their origin in the different methods of observation.

In an addendum to the paper are given the results of some later observations of the mercury lines with a thinner glass plate. The two yellow lines consist of 12 and 11 components respectively, while the bright green line is formed of 21 lines; the dark green line and the blue consist of only 8 and 4 components respectively. E. C. C. B.

1363. *Spectrum of an Irregular Disturbance.* **Rayleigh.** (Phil. Mag. 5. pp. 238–248, Feb., 1903.)—The author refers to a previous paper (Scientific Papers, iii. p. 268), in which he calculated the distribution of energy in a spectrum resulting from the supposition that the white light consists of a random aggregation of impulses. The argument may be extended to all vibrations capable of propagation along a line. Taking a stretched string to which velocities $\phi(x)$ are communicated, the whole energy is proportional to $\int_{-\infty}^{\infty}\{\phi(x)\}^2 dx$. The author calculates this integral in the general case, and then considers an impulse, localised in the neighbourhood of a point, represented by $\phi(x)=e^{-c^2x^2}$, in which case the integral is $\frac{1}{c^2}\int_0^{\infty} e^{-k^2/2c^2} dk$, where k is the frequency. The value of this integral shows that in the spectrum of an absolutely irregular disturbance, the energy between k and $k+dk$ is proportional to dk. The energy curve will then be a straight line if k is the abscissa. If the wave-length $\lambda=\frac{1}{k}$ is the abscissa, the energy curve will have λ^{-2} for ordinate. The author finds a discrepancy between his result and that of Schuster in his application of optical methods to meteorological problems, and to resolve the doubt considers a particular case, and, in conclusion, states that if the velocity curve is arbitrary at every point, the energy between k and $k+dk$ varies as dk, but if the displacement is arbitrary, the energy varies as k^2dk. The author thinks that $\phi(x)$ must be assimilated to the velocity and not to the displacement. The optical theory of gratings offers another illustration of the application of Fourier's theorem to the analysis of irregular curves. To analyse a given curve, reduce the aperture of a telescope to a horizontal strip bounded below by a straight line and above by the curve to be examined. The spectrum thus obtained varies with the curve. Attention must also be paid to the source of light; it is not always immaterial whether this is a point source or a linear one. A. F.

1364. *Spectrum of an Irregular Disturbance.* **A. Schuster.** (Phil. Mag. 5. pp. 344–346, March, 1908.)—The author explains how he arrived at the conclusion given in his "Periodogram of Magnetic Declination" [see Abstract No. 2287 (1900)], and admits that the criticism of Rayleigh [see preceding Abstract] is quite justified. In order to make the optical analogy complete, his definition must be altered, and it is necessary to make the meteorological irregularities correspond to velocities. The author objects to the assertion that Röntgen radiations are due to impulses and not to regular oscillations if this implies that an impulse is smaller than a periodicity of short wave-length. The Röntgen radiations can only contain exceedingly short or very long waves. A. F.

1365. *Absorption Spectra of Metallic Nitrates.* **W. N. Hartley.** (Chem. Soc., Journ. 81. and 82. pp. 556–574, May, 1902; and 83. and 84. pp. 221–246, March, 1903.)—An account of an exhaustive study of the ultra-violet absorption spectra of many nitrates; the complete data from series of observations are given in the two papers, and also the curves of molecular vibrations in which the limits of the absorption are plotted against the molecular concentrations. From his results the author draws the following conclusions: The dissolving of a salt and the dilution of a solution do not cause the separation of the compound into ions, but only a dissociation of such a character that the molecule consists of two parts—the movements of one being influenced by the movements of the other, so that a molecule of the salt is not completely resolved into ions, but is in a condition of molecular tension. This conclusion is based upon the fact that the characteristic absorption is modified when a nitrate of a heavy metal is employed, an exactly similar effect being produced as by weighting an organic molecule. If the absorption were due solely to the NO_3 ion, then the mass of the kation would have no influence. In the case of fatty esters of nitric acid there is no trace of the characteristic banded absorption of the metallic nitrates, but only continuous absorption characteristic of the fatty compounds. E. C. C. B.

1366. *Effect of Absorption on the Resolving Power of Prism Trains, and Methods of mechanically compensating this Effect.* **F. L. O. Wadsworth.** (Phil. Mag. 5. pp. 355–374, March, 1903.)—In this important paper the author deals with the influence of absorption upon the angular limit of resolution given by a train of prisms. He finds that the limit of resolution is much increased by the absorption, and calculates the change in this limit produced by certain definite absorptive powers. These results can be expressed very nearly by the empirical equation $\sigma = a_0 \left\{1 + 0{\cdot}0253(Bb)^2\right\}$ where b is the effective aperture, and B a factor depending upon the absorption; a_0 is the theoretical angular limit of resolution, that is the angle between two rays which can just be resolved, and is equal to $\frac{\lambda}{b}$; σ is the actual angular limit obtained for the theoretical case of an infinitely narrow slit and monochromatic rays.

Now the term Bb can be easily calculated for prisms whose absorptive power is known, because, as the author shows $B = \frac{\beta}{2} \cdot \frac{d\theta}{d\mu} = \beta N \frac{\sin \frac{\phi}{2}}{\sqrt{1 - \mu^2 \sin^2 \frac{\phi}{2}}}$ where θ is the angle of deviation, $\phi =$ the refracting angle of the prisms, N their number, and β their coefficient of absorption. As an example, the Bruce spectroscope of the Yerkes Observatory is quoted; for this instrument $b = 5{\cdot}1$ cm., $\phi = 63^\circ\, 35'$ (mean value), $N = 3$, and μ and β are as follows:—

μ	β	λ
1·653	0·021	5500 tenth metres
1·678	0·071	4300 "
1·693	0·37	3900 "

For the visual region, therefore, $Bb = 0{\cdot}34$ nearly, and σ is less than $1{\cdot}003\ a_0$, so that the resolving power is diminished by less than $\frac{1}{3}$ per cent. On the other hand, at $\lambda = 4300$, $\sigma = 1{\cdot}04\ a_0$, and, at $\lambda = 3900$, $\sigma = 2{\cdot}10\ a_0$, so that in the last case the resolving power is diminished by more than 50 per cent. Similarly in the case of two more powerful instruments, $\sigma = 1{\cdot}35\ a_0$ at $\lambda = 4300$, $\sigma = 11{\cdot}0\ a_0$ at $\lambda = 3900$. At the H and K lines the resolving power is reduced by over 90 per cent. It is evident from these results that it is useless to increase the theoretical resolving power of prisms beyond a certain point. For every value of β there will be a certain limiting value of a_0, and hence of r, for which the practical resolving power will be a maximum. It can be shown that the maximum practical resolving power that can be obtained with a prism spectroscope is one-half what it would be if there were no absorption. In prism spectroscopes, therefore, it is eminently desirable to employ media with small absorption coefficients, the best among the glasses being, as the author shows, light flint. The value of $\frac{d\mu}{d\lambda}$ and hence the resolving power is much lower in this case, but this may be advantageously compensated by increasing the prism angle ϕ. The author discusses, in the next place, the effect of absorption upon the width of the lines as observed; for the value $\beta = 0$ and for monochromatic radiations and infinitely narrow slit, this width $w = 2a_0$. When the factor Bb has finite values this width increases very considerably; for example, when $Bb = 0{\cdot}575$, $w = 2{\cdot}04a_0$, and when $Bb = 7{\cdot}83$, $w = 13{\cdot}5a_0$ or nearly seven times the width for zero absorption. This effect may be considerably reduced by placing a diaphragm over the prism face, but this only with a great loss of light. The curve bounding the edges of this diaphragm is an exponential one depending upon the dispersive term $\frac{d\theta}{d\mu}$ of the prisms used. In conclusion, the author points out that for high resolving powers our only hope lies in the grating; instruments capable of ruling gratings of at least 40 cm. diameter are now being made, one of which is practically completed. E. C. C. B.

1367. *Flame Spectrum of Radium.* **C. Runge** and **J. Precht.** (Ann. d. Physik, 10. 3. pp. 655–657, Feb., 1903.)—A piece of platinum wire with a looped end was heated to redness by an electric current, and a small fragment of radium bromide was brought against it. The salt adhered to the wire and melted, so that a bead was formed which phosphoresced brightly on cooling. When this bead was brought into a Bunsen flame a red coloration was produced, the lines of whose spectrum were visually measured. The wave-lengths of these lines are given in the paper; the most important lines occur at $\lambda = 6653$, 6349, and 4826. Three bands also occur in the red, two of which are very strong, namely, those from $\lambda = 6700$ to $\lambda = 6530$, and from $\lambda = 6330$ to $\lambda = 6130$; these very possibly belong to the spectrum of the compound radium bromide. E. C. C. B.

1368. *Polarisation of Röntgen Rays.* **R. Blondlot.** (Comptes Rendus, 136. pp. 284–286, Feb. 2, 1903.)—By observing the action of Röntgen rays on a small electric spark the author has obtained indications which show that the rays have a plane of action. They act as if they possessed different properties on different sides or are *polarised*, using the word in the widest sense. The plane of action appears to be independent of the orientation of the anti-kathode used; it is always the plane which passes through the Röntgen ray and the kathode ray producing it. The spark being put in the plane of action, on changing its orientation in this plane, the action of the Röntgen rays upon it is a maximum when it is normal to them, and zero when it is parallel or nearly parallel to them. Quartz and sugar appear to rotate the plane of polarisation in the same direction as does light. Rotations of 40° have been observed. J. J. S.

1369. *New Effect of Kathode Rays and of Light.* **L. Zehnder.** (Deutsch. Phys. Gesell., Verh. 1. pp. 85–88, Jan. 15, 1903.)—With some photographic papers, notably collodio-chloride and other printing-out papers, the author notes the following curious effect: By exposure to kathode rays part of the paper is darkened, in this case to a brown colour; on further exposure, this time to daylight, the previously unaffected parts become blackened, while the portions affected by the kathode rays become paler. The result is to turn what, after exposure to the kathode rays, was a negative into a positive. If the darkening due to the exposure to the rays be too great, a reversal does not take place. Radium radiation has the same effect as kathode rays in some cases, but apparently differs when certain bromide papers are employed. Canal rays or ultra-violet light are also found to be efficacious. A comparison with Goldstein's work on the colouring of certain salts in a similar manner is of interest. [See Abstract No. 456 (1902).] R. S. W.

1370. *Induced Radio-activity and the Emanation from Radium.* **P. Curie.** (Comptes Rendus, 136. pp. 223–226, Jan. 26, 1903.)—Referring to his previous paper, in which was studied the disappearance of the radio-activity induced by radium within an enclosure removed from the action of radium and kept at the surrounding temperature [see Abstract No. 719 (1903)], the author here gives the results of his experiments on the action taking place when the enclosure is maintained at 450° C. or at −180° C. He finds that the law of de-activation is still the same throughout this range of temperature, that law being the exponential one—

$$I = I_0 e^{-\frac{t}{\theta}},$$

where I = intensity of the radiation from the walls of the enclosure and $\theta = 4{\cdot}97 \times 10^5$ seconds; the intensity diminishing by one-half in four days. The method of experiment is described, and the results are indicated in curves. Some interesting speculations as to the nature of radio-activity follow. The energy within the enclosure, which produces the activity of the walls, decreases with the time according to a law which is independent of the temperature between —180° and +450°. The author has previously shown that the law is equally independent of other very varied conditions. He suggests that the energy produced by each atom of radium dissipates itself by radiation or by conduction in fluid bodies. Experiment shows that in gases the energy transmitted by conduction is stored up in a special form, and dissipates itself according to an exponential law on provoking the radio-activity of material bodies. Rutherford supposes that thorium and radium emit a *radio-active emanation* which excites the radio-activity of the bodies on which it fixes itself. It is this emanation which produces the induced activity in an activated closed vessel. Rutherford seems to believe in the material nature of the emanation, and thinks it probable that it is a gas belonging to the argon group. The author considers that there is not sufficient evidence to admit the existence of an emanation of matter under its ordinary atomic form. He and Debierne have vainly sought for new rays in the gases extracted from radium. Moreover, the emanation disappears spontaneously in a sealed tube. He considers also that it is not probable that the effects which accompany the existence of the emanation have their origin in a chemical transformation—no chemical reaction is known whose velocity of reaction is independent of the temperature between — 180° and +450°. The author intends to use the convenient term *emanation*, and defines it as *the radio-active energy emitted by radio-active bodies in the special form under which it is stored up in gases and in a vacuum.* This special form of energy in the case of radium is essentially characterised by the *time constant* of the exponential law according to which it dissipates itself. The radio-activity of the solid walls constitutes another form of this radio-active energy, which dissipates itself according to a different law.

The author gives the following theory of radio-activity: Radium of itself does not send out Becqueral rays, it only emits the emanation. In the solid salts of radium, the emanation, not being able to escape, is transformed on the spot into Becqueral radiation. In the case of a solution placed in an enclosure, the emanation spreads itself throughout the enclosure and excites the radio-activity of the walls, the radiation is "exteriorised." What is the support of the energy which constitutes the emanation? One explanation is that of Rutherford, viz., that radium emits a gas which serves to transport the emanation. Again, the support of the emanation may be due to the gas existing in the space concerned, but on this hypothesis it is difficult to explain why the nature of the gas, its pressure and temperature, have no influence on the properties of the emanation. A third hypothesis consists in supposing that the emanation has not ordinary matter for its support, and that there exist centres of condensation of energy, situated between the molecules of the gas, which can be carried along with it. J. J. S.

1371. *Radiation from Polonium and Radium.* **H. Becquerel.** (Comptes Rendus, 186. pp. 481–484, Feb. 16, 1908.)—Proofs have been obtained that the *a*-rays from radium and the radiation from polonium are identical. It was previously pointed out that the degrees of absorption of the two kinds of rays were quite analogous. They are now shown to behave similarly as regards deviability. A photographic method of experiment being adopted, the two proofs—the feeble one of polonium and the intense one of radium—appeared superposable. The direction of the deviation of both kinds of radiation was the inverse of that of the kathode rays. The different kinds of radiation emitted by active bodies may be thus classed: (1) Uranium emits only radiations charged with negative electricity and very penetrating.

(2) Polonium emits only rays charged with positive electricity and very penetrating. (3) Thorium and radium emit both these kinds of radiation. Radium sends out besides very penetrating non-deviable rays. The nature of these is unknown, but they exhibit various characteristics which are also found in the case of Röntgen rays. J. J. S.

1372. *Radio-activity.* **E. Rutherford.** (Phil. Mag. 5. pp. 481–485, April, 1903.)—The criticisms of Becquerel and Curie [see Abstracts Nos. 1190, 1370, and 1371 (1903)] are here referred to by the author, who, while recognising the utility of the photographic method of investigation, provided that the rays emitted are sufficiently intense to affect a photographic plate without too long an exposure, calls attention to recent experiments by himself and Soddy, which show that the emanations from thorium and radium behave like an inert gas and can be condensed when passed through a spiral immersed in liquid air. The author considers the conclusion inevitable that the emanations are gaseous in character. The greater proportion of the radiation from the emanation is also probably material. The results obtained point to the conclusion that radio-activity is a manifestation of subatomic chemical change, and that the radiations accompany the change. J. J. S.

1373. *Induced Radio-activity Excited by Salts of Actinium.* **A. Debierne.** (Comptes Rendus, 136. pp. 446–449, Feb. 16, 1903.)—The behaviour of actinium differs in some respects from that of radium as regards inducing or exciting radio-activity in neighbouring bodies placed with it inside an enclosure. The time constants of the decay of the activity produced allow of distinguishing between the different substances. The activity induced by actinium dies away very rapidly; hence the effect is observed only in the immediate neighbourhood of salts of actinium. The activating centres of energy, according to Curie's hypothesis (called the emanation by Rutherford), are extinguished in the case of actinium before they get far from the source. With radium these activating centres are exhausted slowly. J. J. S.

1374. *Radio-activity of Ordinary Materials.* **R. J. Strutt.** (Nature, 67. pp. 369–370, Feb. 19, 1903.)—It was found that the nature of the walls of the vessel, in which electricity from a charged wire leaked across air, influenced the rate of leak. From this it would appear that the observed ionisation of air is due to Becquerel rays from the containing vessel. The comparative values of the rate of leak with various materials surrounding the charged wire is given in a table. J. J. S.

1375. *Disappearance of Induced Radio-activity.* **P. Curie** and **J. Danne.** (Comptes Rendus, 136. pp. 364–366, Feb. 9, 1903.)—Solid bodies exposed to the action of radium in a closed vessel all become active in the same way. Withdrawn from the enclosure, and thus removed from the action of the emanation, they cease to be active somewhat rapidly according to a definite law. This law is the same whatever the duration of the exposure to the emanation, provided this exposure has lasted sufficiently long (over twenty-four hours). In general, the result is independent of the nature of the body, placed under the same conditions. All substances gain and lose activity in the same fashion. The law of de-activation is represented by the thick-line curve (1) in the Figures 1 and 2. The time, starting from the moment of removing the substance from the enclosure, is represented by the abscissæ, and the logarithm of the intensity of radiation by the ordinates.

After 2¼ hours of de-activation the curve becomes sensibly a straight line. From this moment the intensity, I, of the radiation decreases as a function of the time according to an exponential law of the form $I = I_0 e^{\frac{t}{\theta_1}}$, θ_1 being 2,400 seconds. *The activity diminishes by one-half in twenty-eight minutes.* The law of the diminution of activity is considered as characteristic of the form in which the radio-active energy is stored up at the surface of solid bodies. The intensity of radiation at any moment is represented by the difference of two exponentials. The radio-active energy disappears much more rapidly when it is under the form in which it appears on an activated solid body than when it is in the form of an emanation. In the last case it diminishes by one-half in four days. When the duration of activation is less than twenty-four hours, the law of de-activation during the first hours is much altered, as shown on the curves in Fig. 1. The duration of the enclosure in the activating vessel is indicated on each curve. For an activation lasting five minutes, for example, the intensity of radiation after a quick fall passes through a minimum ($t = 8$ min.), increases then to a maximum ($t = 40$ min.) and then decreases regularly. The manner in which the law of de-activation is transformed as time runs on is shown in the Figure. In all cases the law of de-activation becomes finally at the end of two hours thirty minutes the ordinary exponential law. Curve (1)—the case of long exposure to the emanation—is the limiting normal curve. Whether the material becomes active or is de-activated, the radiation tends towards its limiting value according to the same law. Perhaps it is in the presence and in the transformation of a certain quantity of emanation that it is necessary to seek for the explanation of the singularities of the curves at the commencement of the de-activation. Whilst in general the law of de-activation does not depend on the nature of the activated bodies, yet, for certain substances which have undergone long activation, the final exponential law of de-activation no longer applies. After some hours the activity only decreases very slowly, and requires sometimes many days to decrease by one-half. This phenomenon is especially manifest in the case of celluloid and of caoutchouc. Paraffin and wax show it to a less degree: it is also observed in the case of alum and of lead. The behaviour of these substances is represented on the curves given in Fig. 2.

FIG. 1.

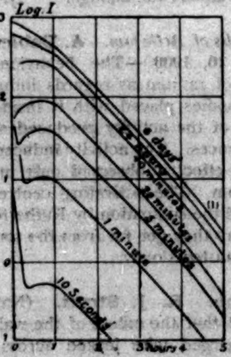
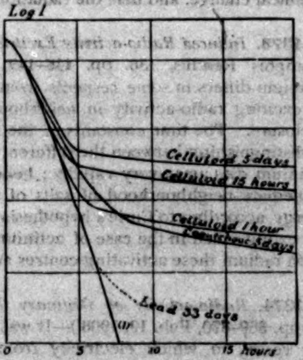


FIG. 2.



J. J. S.

1376. *Radiation Phenomena with Hydrogen Peroxide.* **L. Graetz.** (Phys. Zeitschr 4. pp. 271–274, Feb. 1, 1903.)—The author continues the statement of his view that Russell's hydrogen peroxide experiments are to be explained as radiation phenomena [see Abstract No. 885 (1903)]. He suggests that this radiation may be given off by H_2O_2, may traverse, *e.g.*, a sheet of metal, and then may cause ionisation of the air on the further side, and subsequent re-formation of hydrogen peroxide from moisture and oxygen ions. D. H. J.

1377. *Polonium Radiation.* **F. Giesel.** (Chem. News, 87. p. 133, March 20, 1903. Ber. Deut. Chem. Gesell. 36. p. 728, 1903.)—A note on Mme. Curie's and on Marckwald's methods of purifying polonium. The radiadions from polonium denoted by the terms α-rays and β-rays, can be distinguished from each other by their action on fluorescent screens. The α-radiation acts on a zinc sulphide screen, while the β-radiation affects one of barium platino-cyanide. J. J. S.

1378. *New Light Rays.* **R. Blondlot.** (Comptes Rendus, 136. pp. 735–738, March 23, 1903.)—Referring to his former papers [see Abstracts Nos. 1368 and 1427 (1903)] on the behaviour of rays sent out from a focus tube, the author now shows that the polarisation produced can be changed into elliptic polarisation; the interposition of a sheet of mica destroys the rectilinear polarisation. Moreover, refraction was obtained by means of an equilateral prism of quartz, and also concentration to a focus by the help of a quartz lens. Reflection was also observed. All these results point to the fact that the rays are not Röntgen rays, but a new sort of radiations which are able to traverse black paper, wood, and aluminium. In the experiments made ordinary light was cut off by the interposition of one or other of these substances. The rays do not produce either fluorescence or photographic action. Blondlot thought in his earlier experiments that he was dealing with Röntgen rays, but his later results show that the rays are probably the same as those referred to by Becquerel, who in certain experiments obtained effects similar to refraction and total reflection produced by luminous rays which had traversed aluminium. J. J. S.

1379. *Intensity of Röntgen Rays and Measurement of their Wave-lengths.* **G. Holtsmark.** (Ann. d. Physik, 10. 3. pp. 522–542, Feb., 1903. Extract from the Würzburger Inaugural Dissertation.)—The measurement of the absorption of Röntgen rays has been made by Röntgen and others by photometric methods, whereas Villari, Benoist, Hurmuzescu, M'Clelland, and Righi have accomplished it by taking account of the charges on bodies acted on by the rays. The author uses a vacuum tube in which is a sheet of platinum 10 cm. long and 2 cm. broad. The platinum is connected with one pair of quadrants of a Dolezalek electrometer. The other pair of quadrants is joined to earth, and the quadrant pairs are shunted by 10^9 ohms. The secondary rays produced in the vacuum tube when the Röntgen rays fall on it give their positive charges to the platinum, and hence deflect the electrometer. In order to measure the absorption from the rays by a series of plates of any substance, the substance is interposed between the Röntgen tube and the vacuum tube containing the platinum. The absorption coefficient, q, is given by the following relation: $I = e^{-qd}$ where I = intensity of emergent rays after traversing thickness d of the substance. Preliminary experiment shows that the square of the distance between the tubes varies inversely as the deflection of the electrometer, other things being constant. Absorption was observed in metals, solutions, gases, and liquids, including liquid air. It is found that the absorption coefficient does not decay in proportion to the thickness of absorbing substance; if the coefficients are ordinates, and the thicknesses are abscissæ, the curves found are neither straight lines nor exponential curves. In the case of solutions, the absorption coefficient increases more slowly than concentration of solution. The tables of results show how q varies as (1) the thickness of absorbing substance, and (2) the distance between the vacuum tubes varies. In the second part of the paper, the results obtained above are used to determine the wave-lengths of the rays from the electromagnetic theory, using von Helmholtz's dispersion formula. The method cannot be summarised intelligibly. It is found that $\lambda \propto \sqrt{q}$, λ being the wave-length in a material of absorption coefficient q. P. E. S.

REFERENCES.

1380. *Emanation of Phosphorus.* **G. C. Schmidt.** (Phys. Zeitschr. 4. pp. 293–295, Feb. 15, 1903.)—An experiment is described which confirms the conclusions drawn from former experiments [see Abstract No. 85 (1903)] and questioned by Harms. [See Abstract No. 821(1903).] A fuller paper is to follow in the Annalen. G. E. A.

1381. *Stereoscopic Radioscopy.* **T. Guilloz.** (Comptes Rendus, 136. pp. 611–614, March 9, 1903.)—The author gives further particulars of the method previously described. [See Abstract No. 1195 (1903).] A. D.

1382. *The Stereoscope in Topography and Astronomy.* **Laussedat.** (Comptes Rendus, 136. pp. 22–27, Jan. 5, 1903.) H. B.

1383. *Theorem in Geometrical Optics.* **A. Gleichen.** (Phys. Zeitschr. 4. pp. 226–227 Jan. 15, 1903.)—Another form is found for Straubel's expressions [see Abstract No. 2206 (1902)]. The latter do not hold for rays which have undergone refraction, such as takes place in uniaxial and biaxial crystals. G. E. A

1384. *Construction of Contour Lines by Measurements with the Stereocomparator.* **C. Pulfrich.** (Zeitschr. Instrumentenk. 23. pp. 43–46, Feb., 1903. Communication from the optical workshops of Carl Zeiss.)—A description of the method of the measurement in the stereocomparator of stereoscopic photographs of landscapes in order to obtain the contour lines. [See Abstract No. 708 (1903).] E. C. C. B.

1385. *Polarisation Photometer.* **J. Koenigsberger.** (Phys. Zeitschr. 4. pp. 345–347, March 15, 1903.)—A spectrophotometer is shortly described which can be employed for measurements with ultra-violet rays and for the absolute determination of reflecting powers. [See also Abstract No. 1847 (1902).] G. E. A.

HEAT.

1386. *Non-expansive Alloys.* **C. E. Guillaume.** (Metallographist, 6. pp. 162–165, April, 1903. Letter sent to the American Machinist, Jan. 8, 1903.) —Guillaume has tried to outline the theory of these nickel-steel alloys, going upon the idea of a chemical equilibrium variable with temperature, though as yet the theory is not sufficiently explicit. The author favours the view of Osmond, according to which the passage of iron from the state *Gamma* to the state *Alpha* by lowering of temperature plays an important *rôle* in the phenomena in question ; this passage, which occurs in iron at a high temperature and in a limited interval, is supposed to be brought down to ordinary temperatures and spread over a large interval, and so the existence of slightly expansible alloys is explained. The existence of these has been connected with a series of anomalies embracing all the alloys of iron and nickel and extending to all their properties. The alloys are in practical use in the pendulums of clocks of precision (especially those of German make), and in geodetic instruments. Industrially, the most important alloy is that having the same expansion coefficient as glass ; it is sold as *platinite* by the Société de Commentry-Fourchambault et Decazeville, and is used by several firms as a substitute for platinum in the manufacture of incandescent lamps. [See also Abstracts Nos. 1133 and 1134 (1903).] W. S.

1387. *Expansion of Glass at very Low Temperatures.* **H. Kamerlingh Onnes** and **W. Heuse.** (Konink. Akad. Wetensch. Amsterdam, Versl. 12. pp. 212–223, June 27, 1903.)—As in measuring very low temperatures in the Leyden laboratory, hydrogen thermometers were taken as a basis, an accurate knowledge of the coefficient of expansion of the Jena glass 16^{III} was necessary. The two coefficients of the formula (taken as quadratic) of the linear expansion of the glass below zero were therefore determined, the same investigation being made for Thuringia glass. The two coefficients a and b in the formula for the linear expansion coefficient $L = L_0 (1 + at + bt^2)$, for both sorts of glasses, were found by simultaneously determining, (1) for ordinary temperatures, (2) at about $-90°$, and (3) at a temperature of about $-180°$ C., the length of the test-bars examined. The following results were obtained :—

$$\text{Jena glass } 16^{\text{III}} \begin{cases} L = L_0 (1 + at + bt^2) \\ V = V_0 (1 + k_1 t + k_2 t^2) \\ a = 7{\cdot}78\ 10^{-6} \quad b = 0{\cdot}0090\ 10^{-6} \\ k = 28{\cdot}34\ 10^{-6} \quad k_2 = 0{\cdot}0271\ 10^{-6} \end{cases}$$

$$\text{Thuringia glass } (n^{o}\ 50) \begin{cases} a = 9{\cdot}11\ 10^{-6} \quad b = 0{\cdot}120\ 10^{-6} \\ k_1 = 27{\cdot}33 \quad k_2 = 0{\cdot}0360\ 10^{-6} \end{cases}$$

A. G.

1388. *Differences of Temperature in Convection Currents of Air.* **F. Richarz.** (Ann. d. Physik, 10. 4. pp. 863–878, March 13, 1903. Extract from the Marburger Universitätsprogramm of Oct. 19, 1902.)—The fall of temperature with increase of height in an adiabatically rising or falling stream of air is given by $dt/dx = -g/K$, where K is the isopiestic specific heat in mechanical measure, and this is a fall of 0·0099° C. per metre. Air being artificially made to rise and fall in tubes, the differences of temperature at different points were measured bolometrically, and observations made by S. Löwenherz give a variation of only 5 per cent. from the calculated amount—this being doubtless due to conduction. R. E. B.

1389. *Relation of Specific Heats of Metals to their Atomic Weights. II.* **W. A. Tilden.** (Roy. Soc., Phil. Trans. 201. pp. 37–43, March 21, 1903. Roy. Soc., Proc. 71. pp. 220–221, Feb. 13, 1903.)—Results are given of determinations of the mean specific heats of aluminium, nickel, cobalt, silver and platinum, over several ranges of temperature, the results being as follows :—

Temperature.	Aluminium.	Nickel.	Cobalt.	Silver.	Platinum.
− 182° C. to + 15° C.	0·1667	0·0838	0·0822	0·0519	0·0292
− 78 „ + 15	0·1984	0·0975	0·0939	0·0550	
+ 15 „ + 100	—	0·1084	0·1030	0·0558	0·0315
+ 15 „ 185	0·2189	0·1101	0·1047	0·0561	
15 „ 335	0·2247				
15 „ 350		0·1186	0·1087	0·0576	
15 „ 415		0·1227			
15 „ 435	0·2356	0·1240	0·1147	0·0581	0·0338
15 „ 550		0·1240	0·1209		
15 „ 630		0·1246	0·1234		
0 „ 1000					0·0377
0 „ 1177					0·0388

Taking Q as the amount of heat required to heat unit mass of the metal from + 15 to t, it is found that the general shape of the curves connecting Q and t is the same in all cases, and the connection between Q and t may be assumed to be hyperbolic and expressed by : $Q^2 + aQ + bt^2 + ct + f = 0$. The values of dQ/dt, the specific heats at successive temperatures are also given. The results arrived at in this way are not in accord with the assumption of a constant atomic heat at the absolute zero, as seemed justified for nickel and cobalt. [See Abstract No. 2182 (1900).]

The mean specific heats of a sample of nickel steel containing 36 per cent. of nickel, and having a very small coefficient of dilatation, are also given, and exhibit a variation similar to that met with in pure nickel.

Measurements of the mean specific heats of nickel and silver sulphides give the following results :—

Temperature.	Nickel Sulphide.	Silver Sulphide.
— 182° to + 15°.....................	0·0972	0·0568
15 „ 100	0·1248	0·0737
15 „ 324	0·1333	0·0903

The curves for these sulphides are very similar to those for the metals.

T. H. P.

1390. *Specific Heat of Mercury.* **H. T. Barnes** and **H. L. Cooke.** (Phys. Rev. 16. pp. 65–71, Feb., 1903. Paper read before the British Association at Belfast, 1902.)—The variation of the specific heat of mercury with temperature is here found for a range 2·85° to 33·89°. The continuous-flow method of calorimetry is adopted, similar to that employed for water by Callendar and Barnes. In the present case the flow tube was 45 cm. long and 1 mm. in diameter. The various electrical standards and measurements were as before. For temperature 2·85°, the value of the specific heat is found to be 0·033485, and it decreases continuously to 0·032818 at 33·89°. The results are compared with the work of Regnault, Winkelmann, and Milthaler, who all used the method of mixtures. There is good agreement. J. W. P.

1391. *Rotation Constants in Heat Conduction.* **W. Voigt.** (Gesell. Wiss. Göttingen, Nachr., Math.-Phys. Klasse, 3. pp. 87–90, 1903.)—The rotatory phenomena of heat conduction deduced theoretically by Stokes (1851) and investigated experimentally by Soret (1894), but with negative result, are again examined by means of a more sensitive method given by the author in 1897. [See Abstract No. 620 (1898).] A combination of two plates like a biquartz, rectangular in shape, is made from a thermally uniaxial crystal, cut normal to the axis. A hot body being placed against one of the side surfaces normal to the joining plane, the flow of heat should be such that the isothermals in the plane of the plate have a bend on passing from one half to the other. The isothermals were brought out by the melting of a thin layer of a mixture of elaïdic acid and wax. In each half-plate the isothermals are straight lines. Specimens of apatite and dolomite were tested, but the isothermals over the double plate were quite straight. A test of the personal error in judging the straightness of two lines showed that the former did not exceed 4′. The angle between the isothermals is therefore probably not greater than this amount. G. E. A.

1392. *Phosphoric Oxides and the Heat of Combustion of Phosphorus.* **H. Giran.** (Comptes Rendus, 136. pp. 550–552, March 2, 1903.)—The author determined the heat of combustion of phosphorus in compressed oxygen (at 15 to 20 atmospheres), and found: $P_2 + O_5 = P_2O_5$ (solid) + 369·4 cal. This result is higher than the values given by the older observers, who burnt at atmospheric pressure and failed to obtain complete combustion. The heat of solution of the phosphoric oxide formed is given by: P_2O_5 (solid) + aq. = P_2O_5 (dissolved) + 34·87 cal.; so that the phosphoric oxide in this case is the amorphous variety. Measurements of the heat of neutralisation of solutions of the three phosphoric oxides (crystalline, amorphous, and vitreous) showed that all three oxides give the same acid in freshly prepared solutions, viz., metaphosphoric acid. The heats of transformation of the three oxides are given by:—

P_2O_5 (cryst.) = P_2O_5 (amorph.) + 6·98 cal.
„ (amorph.) = „ (vitreous) + 4·72 „
„ (cryst.) = „ „ + 11·70 „

The heat of formation of orthophosphoric acid from its elements is 305·83 cal. for the crystalline, 303·82 cal. for the fused, and 308·53 cal. for the dissolved acid. The heat of formation of pyrophosphoric acid may now be given as 535·69 cal. for the crystalline, 533·4 cal. for the fused, and 548·62 cal. for the dissolved acid. The revised values for the heats of formation of metaphosphoric acid are: 226·61 cal. for the solid and 236·87 cal. for the dissolved substance. [See also Abstract No. 1080 (1903).] D. H. J.

1393. *Heat of Transformation of White into Red Phosphorus.* **H. Giran.** (Comptes Rendus, 136. pp. 677–680, March 16, 1903.)—The heat of transformation of white into red phosphorus is generally stated to be 19·2 cal. The author shows that this number is much too high. The atomic heat of vaporisation of liquid white phosphorus is 3·74 cal. (calculated from the data of Troost and Hautefeuille), and the atomic heat of vaporisation of solid white phosphorus is 3·89 cal. The atomic heat of vaporisation of red phosphorus is 7·60, so that the heat of transformation of white to red phosphorus is calculated to be + 3·71 cal. The author has tested this result experimentally by determining the heat of formation of the pentoxide and also the heat of formation of the bromide. The results are: Heat of transformation equal + 3·7 cal. and + 4·22 cal.; whence it is seen that the heat of transformation may be taken equal approximately to + 4 cal. There seems also to be an evolution of heat of 0·5 cal. in the conversion of red phosphorus into violet crystalline phosphorus. But this is insufficient to decide as to the identity or individuality of these two forms. A. F.

1394. *Mechanical Equivalent of Heat.* **G. Guglielmo.** (Accad. Lincei, Atti, 12. pp. 204–210, March 15, 1903.)—In some experiments described in a previous paper [see Abstract No. 983 (1903)], the author employed a Fabre and Silbermann calorimeter in which the paddles were held fixed and the calorimeter made to rotate successively in opposite directions. In some new experiments the author observed that if rotation is obtained by means of strings and falling weights there is an increase of heat. To obviate this it is better to apply springs to produce the rotation. The author describes also the measurement of the heat of the solar rays by means of a Fabre and Silbermann calorimeter made of a cylindrical tin 10 cm. high and 5·5 cm. in diameter, and a tube, having the inside surface blackened, by which the rays penetrate into the calorimeter, which is filled with benzoline. In order to have the same temperature inside an apparatus as outside, the author applies in his experiments inside a dilatometer or the bulb of a thermometer, if big enough, paddles or a small rod; then he causes the apparatus to rotate slowly while other paddles are made to rotate outside. A. F.

1395. *Volatilisation of Platinum Electrically Heated in Different Gases.* **L. Holborn** and **L. Austin.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 12. pp. 245–248, Feb. 26, 1903. Communication from the Physikalisch-Technischen Reichsanstalt.)—The loss in weight of platinum, rhodium, and iridium occurs only when they are heated in an atmosphere containing oxygen, and is probably dependent on some chemical change; that of palladium is independent of the nature of the surrounding gas, but is strongly increased by reducing the pressure, and perhaps depends on sublimation. The greatest loss in weight was that of iridium heated in oxygen, which was eleven times as great as when heated in air. The loss in weight of palladium was increased tenfold by reducing the pressure (of hydrogen) from 80 to 0·2 mm. [See also Abstract No. 76 (1903).] T. M. L.

1396. *Movements of Flame in Explosions of Gases.* **H. B. Dixon.** (Roy. Soc., Phil. Trans. 200. pp. 315–352, Feb. 4, 1903. Also Roy. Soc., Proc. 70. pp. 471–483, Sept. 20, 1902.)—Historical introduction (Davy, Bunsen, Berthelot, Le Chatelier, Mallard, Berthelot and Vieille, D. L. Chapman, Dugald Clerk, Liveing and Dewar, von Oettingen and von Gernet). Photographic analysis of detonation wave and their reflections; the reflected wave produced by the collision of a detonation-wave with the end of the tube is mainly a compression-wave; the reflected wave is from 1·56 to 2·22 times slower than the detonation-wave, according to the mixture exploded; the combustion appears to be incomplete (where H_2O or CO_2 is formed) at the moment the reflection-wave is measured. Velocity of a sound-wave in the flame of exploded gases: a sound-wave travelling in the wake of a detonation-wave travels at 1,635 instead of 1,135 m. per sec., on account of the movements and probably also the higher temperature of the gas in the immediate wake of the detonation-wave. Collision of two detonation-waves and the effect of junctions in the tubes; discussion of differences between impact of detonation-wave on a wall and collision between it and another detonation-wave; the detonation-wave starts suddenly, throwing back a strongly luminous wave through the burning gases and leaving a dark space where it started; it travels with constant velocity unless it traverses a junction not rigidly attached (rubber joint), and after being damped down by such an obstacle, it recoups itself and again starts with abruptness; and on collision with a similar detonation-wave moving in the opposite direction, or with a rigid diaphragm, it sends back a reflected wave not so rapid as itself, and as a rule not so luminous, and the collision of two detonation waves produces pressures which readily fracture the tube. The initiation of the detonation-wave, and the wave of retonation (a strongly luminous wave thrown back from the point where the detonation is started), which, the author concludes, runs in gas still burning (Le Chatelier *contrà*, in completely burned gas); photographs of all the initial stages of the explosion; flame travels faster and faster and may overtake the compressional sound-wave produced by the spark, or, in a shorter tube, may only meet the reflection of that sound-wave, which reflection travels more rapidly through the ignited gases and may set up oscillations. Le Chatelier's conclusion combated that the detonation-wave starts in front of the variable wave (which is increasing in velocity) and originates in an invisible wave proceeding in front of the variable wave and with a velocity equal to it. In all cases the explosion begins slowly, and has slight luminosity until the retonation-waves are started by reflection from the ends of the tube; and the detonation does not occur until the flame has run some distance. Numerous photographs reproduced. A. D.

1397. *Entropy.* **J. Swinburne** (Elect. Rev. 52. pp. 52–54, Jan. 9, 1903); **O. Lodge** (Electrician, 50. pp. 560–563, Jan. 23, 1903); **J. Swinburne** (Electrician, 50. pp. 695–696, Feb. 13, 1903); **M. Planck** (Electrician, 50. pp. 694–695, Feb. 13, 1903); **H. Poincaré** (Electrician, 50. pp. 688–689, Feb. 13, 1903); **R. H. Smith** (Elect. Rev. 52. pp. 384–386, March 6, 1903.)—Swinburne contends that a wide meaning should be attached to the term entropy, such that an increase of entropy accompanies every actual transformation, of whatever kind, when all the subjects of the transformation are taken into account, and that without such increase no transformation is possible in nature: that a change of entropy is in no way related to the heat, if any, actually absorbed or emitted during the transformation, though measureable by $\int dH/\theta$, where dH denotes the heat that would have to be absorbed at temperature θ for the same actual change of state if it could be effected reversibly. Lodge takes entropy to be such as to change only when there is transfer of heat, as heat, from one body or part of a body to another at lower temperature, and to be unrelated to any form of energy other than thermal, whether mechanical or chemical or electrical or magnetic. Swinburne characterises Lodge's definition as rank heresy, and instances its inadequacy, pointing out that with the enlarged view there is no ambiguity about temperature. Planck upholds Swinburne, and explains the entropy of a body in a given state as characterising the probability of this state. Poincaré [the text of whose §8 is confused by reason of misprints or slips of pen or translation], assuming the second law to be that of two transformations, A to B and B to A, where A and B are states corresponding to the same energy value, one is always possible, either directly or indirectly, while the other is impossible, either directly or indirectly, shows that there is a function of the co-ordinates which is greater in B than in A if we can pass from A to B, but not from B to A ; this he takes for the entropy, but, in order to get rid of certain difficulties, he takes it in such form that the entropy of any system is the sum of the entropies of all the partial systems that compose it. His conclusions support Swinburne's view, but he allows that there is another definition of entropy. Smith discusses the dimensions of entropy. R. E. B.

1398. *Heat Set Free Spontaneously by Salts of Radium.* **P. Curie** and **A. Laborde.** (Comptes Rendus, 136. pp. 673–675, March 16, 1903.)—It has been proved that the salts of radium disengage heat in a continuous manner. A thermo-electric couple, iron-constantan, of which one junction was surrounded by radiferous chloride of barium, and the other by pure chloride of barium, shows a difference of temperature between the two substances. The radiferous salt was found to have a temperature 1·5° higher than the other. On performing a control experiment with two specimens of pure chloride of barium, the differences of temperature observed were only of the order of magnitude of $\frac{1}{100}$ of a degree. It was sought to measure quantitatively the heat disengaged in a given time by the radium. (1) The heat set free was compared with that produced by the passage of a known current through a known resistance. (2) The heat disengaged by radium was measured by direct observations with Bunsen's calorimeter. One gramme of radiferous chloride of barium which was used in the experiments, set free about 14 small calories per hour. The composition of the product used was, however, not exactly known. According to its radiant activity it ought to have contained about $\frac{1}{6}$ of its weight of pure chloride of barium. Measurements were also made with a sample of 0·08 gramme of pure chloride of radium. These led to results of the same order of magnitude as before. One gramme of radium disengages a quantity of heat which is of the order of 100 calories per hour. One atom-gramme of radium (225 grammes) would set free each hour 22,500 calories, an amount comparable with that of the heat produced by the combustion in oxygen of 1 atom-gramme of hydrogen.

The disengagement of such a quantity of heat cannot be explained by any ordinary chemical transformation. If an internal transformation takes place this must go on with extraordinary slowness, and must be due to a modification of the radium atom itself. As radium exhibits no notable variations in the course of years, the energy set in action in the transformation of the atoms would be exceedingly great. Another hypothesis as to the cause of the phenomenon would be that the radium utilises some exterior energy whose nature is unknown. J. J. S.

REFERENCES.

1399. *Radiomicrometer.* **C. C. Hutchins.** (Amer. Journ. Sci. 15. pp. 249–253, April, 1903.)—Details are given by which the difficulties attending the construction of satisfactory radiomicrometers may be overcome. R. E. B.

1400. *Thermostat.* **C. Marie** and **R. Marquis.** (Comptes Rendus, 136. pp. 614–615, March 9, 1903.)—The authors describe a thermostat heated and regulated electrically; the temperature of the liquid (acetone, on account of its high coefficient of dilatation) is maintained constant within 0°·02 to 0°·03, and that of the contents of the flasks within 0°·01. A. D.

1401. *Richard Thermograph.* **V. Chiptchinsky.** (Acad. Sci. St. Pétersbourg, Bull. 15. pp. 441–450, Nov., 1901.)—The author describes a protective device surrounding the rotating portion of the Richard thermograph. Tests made by the author show the useful character of this contrivance, proving that the fitting of thermographs with the apparatus in the form described, though not fully replacing ventilators, gives nearly as satisfactory results. A. G.

1402. *Joule-Thomson Effect.* **P. V. Bevan.** (Cambridge Phil. Soc., Proc. 12. pp. 127–134, April, 1903.)—The experimental determinations of this effect hitherto made are not sufficiently accurate to lead to any reliable approximation to the characteristic for fluids. R. E. B.

1403. *Characteristic for Fluids.* **H. Moulin.** (Comptes Rendus, 136. pp. 881–883, April 6, 1903.)—The author's former suggestion [see Abstract No. 1439 (1900)] is now modified to $p = RT(v-a)^{-1} - bv^{-2/3} + R'T(v-a)^{-1/3}$, and a variant form $pv = RT - b(v-a)^{1/3} + R'T(v-a)^{2/3}$ is also given. R. E. B.

1404. *Temperature of Inversion in the Joule-Thomson Experiment.* **S. Nakamura.** (Mathematical and Physical Soc. Tokyo, 1. 12. pp. 79–87, 1901–1903.)—This temperature is calculated on the several assumptions of van der Waals', Clausius', and Reinganum's characteristics. R. E. B.

1405. *Efficiency and the Second Law of Thermodynamics.* **K. v. Wesendonk.** (Phys. Zeitschr. 4. pp. 329–333, March 15, 1903.)—A detailed exposition of Planck's criticism of Friedenthal's views. [See Abstract No. 1035 (1903).] R. E. B.

1406. *Energy of a Column of Air.* **A. Schmidt.** (Ann. d. Physik, 10. 2. pp. 449–452, Jan. 27, 1903.)—This paper deals with the energy of an infinitely high column of air, g and T remaining constant. The author combats the equation generally found in meteorological literature, that $p\cdot dv = R\cdot dT + g\cdot dh$. Polemic with F. M. Exner. [See Abstracts Nos. 1323 (1902) and 239 (1903).] A. D.

SOUND.

1407. *Longitudinal Vibrations of Rods of Varying Cross-section.* **J. Nabl.** (Akad. Wiss. Wien, Sitz. Ber. 111. 2a. pp. 846–856, May and June, 1902. From the Physik. Cabinet of the k.k. Univ., Vienna.)—The author develops the theory for conical and cylindrical rods. The nodal points are as follows :—

Conical Rod.			Cylindrical Rod.		
Fundamental Tone.	First Overtone.	Second Overtone.	Fundamental Tone.	First Overtone.	Second Overtone.
$x = 0\cdot433$	$x_1 = 0\cdot23$	$x_1 = 0\cdot160$	$x = 0\cdot500$	$x_1 = 0\cdot25$	$x_1 = 0\cdot166$
	$x_2 = 0\cdot73$	$x_2 = 0\cdot492$		$x_2 = 0\cdot75$	$x_2 = 0\cdot500$
		$x_3 = 0\cdot823$			$x_3 = 0\cdot833$

Experimental verifications are given. A. D.

1408. *Phase in Relation to Timbre.* **F. Lindig.** (Ann. d. Physik, 10. 2. pp. 242–269, Jan. 27, 1903. Abstract of Kiel dissertation.)—Timbre does not depend on the relative phases of overtones, except in so far as identical overtones of different simultaneous fundamentals may eliminate themselves, wholly or partially, by mutual interference due to phase-differences. A. D.

1409. *Sound produced by Sand in Motion.* **Lortet.** (Comptes Rendus, 136. pp. 925–926, April 14, 1903.)—Near the Abu-Simbel Temple in Nubia, on the banks of the Nile, there is a slope of very fine sand. A sound like the humming of a dynamo is heard when one descends this slope ; the sound continues for several minutes though the observer keep quite still. H. B.

REFERENCE.

1410. *Optical Composition of Sounds.* **G. Zambiasi.** (Accad. Lincei, Atti, 12. pp. 48–53, Jan. 18, 1903.)—A method of making figures analogous to Lissajous' figures, is described, by the optical composition of three or more sounds. A. D.

ELECTRICITY AND MAGNETISM.

THEORY AND ELECTROSTATICS.

1411. *Electromagnetic Mass of Electrons.* **W. Kaufmann.** (Gesell. Wiss. Göttingen, Nachr., Math.-Phys. Klasse, 3. pp. 90–103, 1903.)—A continuation, by more exact methods, of the research dealt with in Abstract No. 457 (1903). A particle of pure radium bromide is here used as the source of radiation. Photographs of the phenomena were obtained and theory applied to the measurements taken from them. The author concludes that not only Becquerel rays, but also kathode rays, consist of electrons, the nature of whose mass is purely electromagnetic. E. H. B.

1412. *Ionisation of Gases.* **P. Langevin.** (Annal. Chim. Phys. 28. pp. 289–384, March, and pp. 433–530, April, 1903.)—This is a complete *résumé* of recent theory and experiment with regard to the new ideas as to electric phenomena, based on the notion of corpuscles or electrons. The work of Lorentz and of Larmor, as well as the theories and researches of Crookes, Zeeman, J. J. Thomson, and others are summarised and commented upon. J. J. S.

1413. *Electric Convection.* **H. Pender** and **V. Crémieu.** (Comptes Rendus, 136. pp. 548–550, March 2, 1903.)—The authors of this short paper state the directly opposite results each obtained when working on this subject separately. [See Abstracts Nos. 646 and 909 (1903).] Now working together, they seek to account for the contradiction, and they show that all the convection experiments yet made have involved the charging and discharging of discs already in motion. But secondary effects can be detected when this process is performed on bodies at rest, and they may therefore also be produced in the case of moving discs. The divergence between the former results of the authors may be due to the manner in which these secondary phenomena are modified by the motion. The authors therefore propose to make a simple experiment which will not be subject to these effects. It consists in charging slowly a disc, at rest but capable of movement, very well insulated and forming the internal plate of a condenser. Setting this disc in motion, when charged and insulated, ought, if the magnetic effect exists, to be accompanied by a permanent deflection of a sensitive astatic magnetic system in the neighbourhood of the disc, with a return to zero position when the motion is stopped. The authors hope to have results soon. W. C. H.

1414. *Electric Convection.* **V. Crémieu** and **H. Pender.** (Comptes Rendus, 136. pp. 955–957, April 20, 1903.)—The authors describe some apparently contradictory results, but their conclusions are (1) that charged discs turning in air *do* produce magnetic effects on a needle in the sense demanded by the principle of electric convection, and in amount within 10 per cent. of that calculated ; (2) the interposition of armatures between the discs and the measuring apparatus seems to have no influence on the results. [See Abstracts Nos. 83 and 909 (1903) and preceding Abstract.] P. E. S.

1415. *Electric Convection.* **Vasilesco-Karpen.** (Comptes Rendus, 136. pp. 609–611, March 9, and pp. 998–1000, April 27, 1903.)—Rowland's effect distinctly obtained, with deviations proportional to velocities. A variable charge slips round a rotated charged disc, at N revolutions per second in relation to the disc, where $N = e/\overline{R(2dq + dQ)}$; dQ being the instantaneous charge on an annulus of the disc infinitely narrow and of resistance R, e the induced e.m.f. in the annulus, and dq the quantity set free by the e.m.f., and N is proportional to the thickness of the disc and to the induced e.m.f. Where the convection-field acts direct on a magnetic needle there will be no slip or lag, but the charge will travel round with the disc ; and the lag will be inappreciable in the case of insulated sectors, and of gilding or other thin metallic coating. If the quantities of electricity separated in a conducting disc be much greater than the electrostatic charges, again there will be no appreciable lag. A. D.

1416. *Two Forms of the Principle of Least Action in the Theory of Electrons.—The Elementary Electrodynamic Force.* **K. Schwarzschild.** (Gesell. Wiss. Göttingen, Nachr. Math.-Phys. Klasse, 3. pp. 126–131, and pp. 132–141, 1903.)—Part I. By the Principle of least Action may be understood the variation of the formulæ of Lagrange and Hamilton. Two methods are given in this paper, corresponding, according to the author, to the two methods in hydrodynamics adopted respectively by Euler and by Lagrange. In the first method we have, using Maxwell's symbols for electric current and vector potential, and ϕ for electric potential, K_x, electromotive force in x, $= -\frac{d\phi}{dx} - \frac{dF}{dt}$ &c., R_x, magnetic force in $z = \frac{dF}{dy} - \frac{dG}{dx}$, &c., whence the complete mechanical force in x is—

$$P_x = -\frac{d\phi}{dx} + u\frac{dF}{dx} + v\frac{dG}{dx} + w\frac{dH}{dx} - \frac{dF}{dt} - u\frac{dF}{dx} - v\frac{dF}{dy} - w\frac{dF}{dz}$$

The last four terms in this expression represent the total differential $\frac{dF}{dt}$ whence, if $L = \phi - (Fu + Gv + Hw)$, $P_x = -\frac{dL}{dx} + \frac{d}{dt}\frac{dL}{du}$, which is the Lagrangian form. Then the Principle of Least Action is expressed by $\delta\int dt(-T + \Sigma eL) = 0$, in which T is kinetic energy of mass, and the summation ΣeL includes all electric charges in the field. The writer adopts the retarded potential of Levi-Civita. The second method adopted is obtained by adding to the integral of Hamilton's principle the expression—

$$\int dt\, dw\left(\frac{R^2 - P^2}{8\pi} + \chi L\right)$$

in which χ denotes density of electricity in the element dw, R and P the resultant magnetic and electric forces, and the time integration is over an interval of time, at the beginning and end of which the variations vanish. The author claims by this second method to obtain all the formulæ of the Lorenz-Wiechert theory.

Part II.—*The Elementary Electrodynamic Force.*—The object of the writer in Part I. was to obtain the most general expressions which should implicitly contain the equations of the electromagnetic field. In the present part he proceeds in the opposite direction, and seeks to determine the force which an electric charge e at x, y, z, moving with velocity q, exerts on another charge e'

at x', y', z', moving with velocity q' at distance r. It is understood that the force on e' exerted by e at a given instant depends on the motion of e at the time $-r$ before that instant, the velocity of light being taken as unity. Wiechert found for the statical and vector potentials due to e under these circumstances $\phi = \frac{e}{r(1-q\cos(q,r))}$; $F = \frac{eu}{r(1-q\cos(q,r))}$. Hence, after suitable geometric treatment, the author finds for the electric force on e' a quasi-potential $P = \frac{1}{r} + \frac{1}{\phi}\overline{\frac{d\phi}{dt}}$, from which the force can be derived by differentiation according to x'. The bar over any symbol denotes that the quantity referred to is to be regarded as a function of five independent variables, x', y', z', t, t'. The absence of the bar denotes that $t = t' - r$ is to be assumed, so that the quantity is to be treated as a function of x', y', z', t'. The mechanical and magnetic forces are easily deduced from the electric force. Several special cases are separately treated. S. H. B.

1417. *A Problem in Electrostatics.* **E. Almansi.** (N. Cimento, 5. pp. 242–249, April, 1903.)—The author here returns to the consideration of the same problem which he discussed in N. Cimento, August and October, 1902. [See Abstract No. 459 (1903).] A conductor C has a charge E in equilibrium. Another small conductor c (*corpo di prova*), or electroscope, is made to touch C at a point at which the density (or near which the mean density) is h. The small conductor c acquires a charge e, and the question is of the ratio e/h. If U be the potential of the charge on C in equilibrium, U_0 its constant value on C, V the potential of any mass M within C, then $\int V\frac{dU}{d\nu}dC = U_0\int\frac{dV}{d\nu}dC$, $d\nu$ being an element of the normal external to C, that is, since $-\frac{dU}{d\nu} = 4\pi h$, and $\int\frac{dV}{d\nu}dC = 4\pi M$. He now assumes M to be a *doppio strato* whose mass is zero. Hence $\iint VhdC = 0$. Then he supposes a plane dividing C into two parts, A and a, and on this plane the *doppio strato* is placed; ω is the part of it intercepted by C. Let μ be the density on ω, positive on the side towards a, and μ_0 be its least value. Then if θ be any positive quantity less than μ_0, it is possible to describe a surface σ outside of C and bounded by the contour of ω, such that at every point of σ, $V = \theta$. This surface is the surface of the electroscope c.

It is then proved that $e = \int\frac{V-\epsilon}{\theta-\epsilon}hda$, where ϵ is the mean value of V over A. Under certain conditions specified this becomes $e = \int\frac{V}{\theta}hda$. And if $\int\mu d\omega = a$, this is further reduced to $\frac{e}{h} = \frac{2\pi a}{\theta}$. If, further, $\mu = 1$, $a = \omega$, this leads to the result that the quantity of electricity e drawn by c from C is sensibly equal to twice the quantity of the distribution on C in equilibrium which is covered by the base of c. S. H. B.

1418. *Electric Endosmose.* **M. Smoluchowski.** (Acad. Sci. Cracovie, Bull. 3. pp. 182–199, March, 1903.)—By electric endosmose is meant the passage of a liquid through a diaphragm, or narrow tube, consequent on an electric current circulating in the same or opposite direction. The phenomena were investigated by Helmholtz, subsequently by Wiedemann and Freund.

In the present paper the writer's principal object is to show that Lamb's theory (Phil. Mag. 25, 1888, p. 52) and Helmholtz's theory lead to the same results. Helmholtz assumes continuity in the electric "double couche," while Lamb regards it as a condenser of which the two plates can slide one over the other under the influence of a tangential force. The phenomena are discussed for the two cases, one in which when the passage of the liquid is interrupted an increase of pressure occurs at the kathode and diminution at the anode. This he calls electro-osmotic pressure. The other case is that in which the passage of the liquid under external pressure produces a difference of potential. S. H. B.

1419. *Electromagnetic Field due to an Electric Charge moving uniformly in a Circle parallel to an indefinite Conducting Plane.* **G. Picciati.** (Acad. Lincei, Atti, 12. pp. 159–165, March 1, and pp. 185–194, March 15, 1903.)—In these papers the consideration of the problem discussed in a former note [see Abstract No. 1041 (1903)] is resumed, with the modification that a conducting plane is introduced. As a consequence we have on that plane a varying distribution of electricity, giving rise to a statical potential and a vector potential. The same method and notation are employed as in the first note. The mathematical treatment cannot be abstracted with advantage. S. H. B.

1420. *Propagation in Conducting Media.* **M. Brillouin.** (Comptes Rendus, 136. pp. 667–669, March 16, and pp. 746–749, March 23, 1903.)—The general equation for propagation in a conducting medium is—

$$\Delta\phi = \frac{\partial^2\phi}{\partial t^2} + 2\frac{\partial\phi}{\partial t} \quad \text{........................}(1)$$

if the variable t denote the time multiplied by $2\pi k\Omega^2/\mathrm{K}$, ($\Omega$ velocity of light, k conductivity, K dielectric constant), and x, y, z denote the distances multiplied by $\Omega\sqrt{\mathrm{K}\mu}$ (μ magnetic permeability). In the first part of this memoir the writer finds an integral of this equation for the case of a point source of finite duration at x_0, y_0, z_0, in the form $\phi = e^{-t}\Psi$, and ψ is expressed in Bessel's functions. This function ψ is shown to be precisely that which we require to transform by Kirchhoff's method any integral of (1) given in the form $e^{-t}\mathrm{V}$. This transformation is discussed for several cases, one already treated by Birkeland, and one which illustrates Huyghen's principle. In the second part the writer considers Poincaré's integral—

$$\mathrm{V} = \frac{e^{-t}}{2p}\left\{g\overline{r+t} + g\overline{r-t} + \int_{r-t}^{r+t} d\xi\left[g_1[\xi]\mathrm{I}_0\zeta + g[\xi]\frac{\mathrm{I}'_0}{\zeta}\right]\right\}$$

(where $\zeta^2 = t^2 - (r-\zeta)^2$, and g, g_1 are functional symbols), applied to an indefinite medium, when the initial state at any point is a function of the distance r, from a fixed point. The initial state is—

$$\mathrm{V}_0 = \frac{g(r)}{r}, \quad \left(\frac{d\mathrm{V}}{dt}\right)_0 = \frac{g_1(r) - g(r)}{r}.$$

If $r = 0$ is not a source, $g(\xi)$ must contain only odd powers of ξ. If we wish to make $\frac{d}{dr}(r\mathrm{V}) = 0$ when $r = 0$, $g(\xi)$ must contain even powers only of ξ. From these data he finds the integrals for isotropic sources, and obtains two integrals which lead to the formation of integrals for doublets, and are applicable to the telegraphist's equation. He points out that a single isotropic source of electricity is incompatible with Hertz's theory. If there are two sources they ought to be regarded as a chain of doublets, forming a line of discontinuity in the conductor. S. H. B.

1421. *Mass of Ions in Air and their Adsorption on the Earth's Surface.* **E. Riecke.** (Gesell. Wiss. Göttingen, Nachr. Math.-Phys. Classe, 2. pp. 39–45, and pp. 83–86, 1903.)—In the first of these memoirs (which form a continuation of those before abstracted) [see Abstract No. 1218 (1903)] the author obtains expressions for the diffusion coefficient and mobility of the ions. A uniform field of force F in electrostatic measure is assumed, ϵ is the charge on a positive ion, then he finds for the velocity acquired under the action of the field $\overset{+}{g} = \overset{+}{U}\epsilon F$. Also if μ_p denote the mass of the positive ion, u_p its molecular velocity, l_p its mean free path, $\overset{+}{U} = \frac{2}{3} l_p / \mu_p u_p$, and again, writing $u_p^2 = 8R_pT$, where R_p is the gas-constant for positive ions—

$$\overset{+}{U} = \frac{2l_pu_p}{9\mu_pR_pT}$$

He obtains for the coefficient of diffusion $\overset{+}{k} = \frac{2}{9} l_p u_p$. The mean free path is calculated from Maxwell's formulæ. The results are then applied to air, for which he says for positive ions $\overset{+}{k} = 0{\cdot}0274$, for negative ions $\overset{-}{k} = 0{\cdot}0420$, and are given in a table and shown graphically. Owing then to the mass of the ions, the results present some difficulty. As a reasonably probable conclusion, he says the mass of a positive ion is greater than that of a molecule of air, and that holds also for a negative ion. To find definite values it is necessary to resort to the equations obtained in the before abstracted papers, and an extension of them. Results are given as probable for the masses, and also for the dimensions of positive and negative ions. In the second part the earth is assumed to have a permanent negative charge, and this is assumed to arise from negative ions being absorbed or *adsorbed* by it with greater facility than positive. By *adsorption* appears to be meant either that the ion with its negative charge on reaching the earth adheres to it, or gives up its charge to the earth. Let E be the electrostatic force towards the earth, U the absolute mobility of a positive ion, V that of a negative ion. Also let xu_p denote the number of positive ions which strike the earth, per unit area per second, yu_n the same for negative ions. Let c denote the velocity of light. Then taking into account the electric force due to the earth's negative charge, he obtains the equation, $c(U\overset{+}{n} + V\overset{-}{n})E = yu_n\overset{-}{n} - xu_p\overset{+}{n}$. From which, by application of the method developed in the preceding papers, he calculates the absorption, but the results cannot, he says, be tested at present. S. H. B.

1422. *Atmospheric Electricity at Mattsee.* **E. R. v. Schweidler.** (Akad. Wiss. Wien, Sitz. Ber. 111. 2a. pp. 1463–1488, Oct. and Nov., 1902. From the II. Physik. Institut der k.k. Universität. of Vienna.)—Mattsee is situated between lakes and wooded hills north of Salzburg. The observations were made in July to September, 1902, with an Elster-Geitel instrument without cylindrical guard. The maximum dispersion occurs about 3 p.m.; q is a little smaller than 1 in the morning, and a little greater in the afternoon. H. B.

1423. *Dispersion of Atmospheric Electricity in Misty Weather.* **A. Gockel.** (Phys. Zeitschr. 4. pp. 267–270, Feb. 1, 1903.)—The author spent a September week on the Rothorn at an altitude of 2,300 m., taking observations on dispersion, fall of electric potential, air pressure, temperature and relative humidity. The mountain was rarely free from mist, Lake Brienz down below, never. On the only clear day the fall of potential was 300 volts/*m*, and increased to 680 volts when the mist rose; the $q(a-/a+)$, generally between 1 and 2, rose to 5, and might have reached Elster and Geitel's highest values (on Säntis) if the instruments had been quite alike. In misty weather q was smaller. The surface fog seems to bring up positive ions, and, further, to arrest the mobility of the negative ions; but the effect of mist is very complicated. In clear weather positive charges seem to be more rapidly dispersed than negative charges (q therefore less than 1) when the barometer is falling and there are ascending air currents. H. B.

1424. *Atmospheric Electricity on the Mont Blanc.* **G. Le Cadet.** (Comptes Rendus, 136. pp. 886–888, April 6, 1903.)—The author had four days, August 31 to September 3, of fine weather on the top of the Mont Blanc (4,801 m.). The electric potential (radium collector) at a point 1 m. above the snow, automatically recorded, had a maximum in the afternoon between 3 and 4 p.m., and a minimum about 3 a.m. The fall of potential (2 wick collectors) was about 600 volts/*m*, with a maximum of 1,000 volts and a minimum of 100 or 200 volts at the hours stated. The dispersion (Elster-Geitel instruments) was about ten times as strong for negative charges as for the positive charges, the value of q varying between 4·8 and 16·6. This increase of the apparent conductivity of the air with the altitude agrees with Elster and Geitel [see Abstract No. 1917 (1901)], and the diurnal variation with A. B. Chauveau. [See Abstracts Nos. 1060 and 1061 (1900).] H. B.

1425. *Lightning.* **B. Walter.** (Ann. d. Physik, 10. 2. pp. 393–407, Jan. 27, 1903.)—This article deals with the photography of induction-coil sparks, on a rapidly moving film. Preliminary discharges precede the main spark; both poles take part equally; and the preliminary discharges are parallel to one another in their irregularities of course (dust in the air, &c., conductivity acquired by certain air particles during the preliminary discharges). The series of discharges takes $8{\cdot}2 \times 10^{-4}$ seconds. Corresponding phenomena in lightning discussed: photographic records. When the main flash reaches the earth its intensity oscillates in the earth, wave-fashion, possibly on account of electric oscillations between the earth and clouds. Even apparently erratic discharges swerving to one side are preceded by preliminary discharges in the apparently abnormal direction; and in many cases these preliminary discharges prepare paths along branching lines which look like a map of a river-system. Duration of one of the flashes, 0·00885 second. Striking photographs are given. A. D.

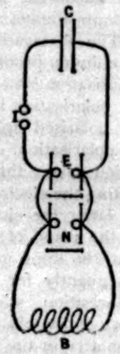
DISCHARGE AND OSCILLATIONS.

1426. *Conductivity produced in Gases by Ultra-violet Light.* **J. S. Townsend.** (Phil. Mag. 5. pp. 389–398, April, 1903.)—The author's theory [see Abstract No. 2244 (1902)] is here applied to HCl gas and water vapour with results consistent with previous work. It does not, however, explain the whole of the facts, and further investigation is necessary. In opposition to other physicists, Townsend finds reasons for believing that the velocity acquired by an ion moving under a field of 10 volts per centimetre may be sufficient to produce new ions by collision. R. S. W.

1427. *Action of a Polarised Beam of Radiations on Small Electric Sparks.* **R. Blondlot.** (Comptes Rendus, 136. pp. 487–489, Feb. 23, 1903.)—Referring to his experiments on the polarisation of Röntgen rays, the author further inquires whether polarised light has a similar effect on a small electric spark. [See Abstract No. 1368 (1903).] This he has found is the case. On substituting for the focus tube used in the earlier experiments on the Röntgen rays, an electric spark which is reflected from a glass surface and is then partially polarised, he found that similar effects were obtained. The spark used passed horizontally between two aluminium points. Direct influence of the spark is precluded by a 3-in. screen pierced by a hole to allow the polarised beam reflected from the glass surface to pass. A sheet of quartz slightly silvered is also placed in the path of the beam. The thin layer of silver allows very refrangible radiations to pass through it. On observing the little spark, arranged horizontally, it is found to be more brilliant and white when acted on by the polarised beam. When the latter is cut off by a thick sheet of glass the spark becomes feeble and reddish. When the spark is arranged vertically the interposition of a screen has no effect; the action of the light upon it does not exist. On causing the spark to turn round the axis of the polarised beam falling upon it, the brilliance passes through a series of changes, being at a maximum when it is horizontal and at a minimum when vertical. The appearances are exactly the same as with the Röntgen rays and the S rays. The observations show that a polarised beam of the radiations emitted by aluminium produces a notable reinforcement of the spark when its plane of polarisation is normal to that spark and does not act upon it when its plane of polarisation is parallel to it. In other words, there is a *plane of action* of the polarised light on the small spark, and this plane is normal to the plane of polarisation. In the case of the Röntgen rays the plane of action is that which passes through the Röntgen ray and the generating kathode ray. Adopting the electromagnetic theory for light and for the Röntgen rays: in the latter the electric vibration produced by the kathode rays can only be in the plane of these latter or in the plane of action. Analogy indicates that the same must hold true in the case of the luminous vibrations, and consequently for these the electric vibration is normal to the plane of polarisation, which agrees with the views of O. Wiener. Adopting the theory of the elastic ether, the ethereal vibration which is produced by moving matter in the kathodic emission is still in the plane of the Röntgen ray and of the generating kathode ray, or in the plane of action. The conclusion from analogy is, then, that in a ray of polarised light the vibrations are normal to the plane of polarisation: this is the hypothesis of Fresnel. J. J. S.

1428. *The Electric Spark.* **J. Semenov.** (Comptes Rendus, 136. pp. 926–928, April 14, 1903.)—In previous papers the author has shown that in the electric spark, where there is disintegration of the electrodes, the material from the negative electrode does not necessarily go to the positive electrode, but may be deviated from this course or completely stopped without causing interruption of the electric current. [See Abstracts Nos. 2079 (1902) and 95 (1903).] In the present paper the material from the positive electrode is under observation to see if it could be deviated from the path to the negative electrode without causing stoppage of the discharge. One method of experiment adopted was to cause the spark to pass through a flame and to examine the deposits produced on glass plates near and round the spark; the other method was to make a spectroscopic investigation of sparks passing through a long, narrow flame. The former investigation shows that the gas and vapours traversed by a spark are projected round the spark in every direction owing to the sudden rise of temperature. The direction of discharge appears to have no influence on the direction of this projection. The other (*i.e.*, spectroscopic) experiments show that, in the conditions there prevailing, the metallic vapours which are produced at the two electrodes, instead of travelling to the opposite electrode, are carried away by the flame, so that the middle portion of the spark is free from them. The author therefore concludes that the transport of matter by a spark is not an essential condition for an electric discharge, but only a secondary effect. W. C. H.

1429. *Ultra-violet Rays and Sparking Distance.* **R. Swyngedauw.** (Soc. Franc. Phys., Séances, 3. pp. 140–158, 1902.)—This paper deals with the influence of the velocity of charge of an exciter on the lengthening of its explosive distance by ultra-violet rays. The author has previously announced that ultra-violet light lengthens the explosive distance of an exciter much more with a rapid charge than with a slow charge. [See Abstracts Nos. 381 and 1718 (1901).] This may be expressed by saying that ultra-violet light lowers explosive dynamical potentials much more than static explosive potentials. There are apparent contradictions of this law, which the author's experiments lead him to consider are due to a difference in the velocity of charge of the exciter. Whilst in the case of the dynamical charge the potential varies very rapidly, it varies slowly in the case of the static charge. The distinguishing characteristic which marks the two cases is the rate of variation of the potential, $\frac{dV}{dt}$. As the action of the ultra-violet rays makes itself felt in a time notably shorter than the discharge employed, the following proposition may be stated. The lengthening of the explosive distance of an exciter under the action of ultra-violet light is a function increasing with the velocity of charge at the instant when the spark passes. This proposition has been experimentally verified, the method adopted being that previously



used, and consisting of two exciters placed in parallel. The arrangement may be concisely described thus: Between two points on the discharge circuit of a condenser two similar condensers, E and N (see Fig.), are arranged in parallel, and are at each instant at the same potential.

On placing the exciter N in constant physical conditions and on charging by an invariable method of charge, the explosive potential of N is kept constant. On placing E in given physical conditions the explosive distance of E can be determined for any potential whatever of N (remaining constant), on determining the equivalent explosive distance of the two exciters. To charge the exciters by a statical method, their poles are joined in derived circuit with those of a Holtz machine, and with the coatings of one of two jars of 0·005 microfarad capacity. To charge dynamically, the plates of a jar, C, are connected between them by a circuit containing a coil and an interrupter formed of an exciter with a spark-gap between balls, I, and the two derived exciters are placed on a derived circuit between the extremities of the coil (see Fig.). When a spark passes at the exciter I, the coil is traversed by the discharge, and the potential difference between the poles of the derived exciters in contact with its extremities passes (in a time very short compared with the duration of the spark) from the value zero to the maximum or critical potential which is near to the potential to which the condenser is charged; and the rate of charge of the exciter dV/dt passes from an unknown value to the value zero that it attains at the maximum potential. Considering that for a determined discharge, that is, for one and the same explosive distance of the exciter I, each explosive distance of the derived exciter N corresponds to a different explosive potential and to a different rate of charge of the exciter, if the author's proposition is true it ought to be found (1) that to each explosive distance of the derived exciter not lit up corresponds a different lengthening of the explosive distance; (2) that when the explosive distance of N tends towards its critical distance, the lengthening of the explosive distance diminishes whilst tending towards the statical lengthening, that is to say, towards a value inappreciable in the actual experiments. Experiment verifies the above propositions. It also follows as a result of experiment that (3) if the lengthening of the critical distance under the action of ultra-violet rays is greater than the statical lengthening, the critical spark passes for a value of $\frac{dV}{dt}$ different from zero, and consequently for a potential lower than the maximum potential. Moreover, the following proposition is found to be true: (4) The lengthening of the explosive distance is a function of the rate of charge of the exciter. Experiment shows that the explosive potential is lowered when the velocity dV/dt is negative. From this it follows as an unexpected consequence that to discharge an exciter illuminated by ultra-violet rays and charged to a potential near its statical and explosive potential, it suffices to rapidly diminish the potential. When the exciter is not exposed to such rays it is necessary in all cases to raise its potential in order to discharge it. To prove proposition (4) the author has carried out experiments similar to that of Lodge on the overflow of a jar. He also refers to and explains according to his views experiments described by Hertz, Jaumann, and Warburg. The general conclusion arrived at is that ultra-violet light lengthens the explosive distance of an exciter exposed to it, by a quantity which is the greater according as the rate of charge of the exciter is more rapid at the instant of the passing of the spark. This proposition leads to the explanation of a number of experiments hitherto inexplicable. J. J. S.

1430. *Luminosity and Heating of Electric Sparks.* **B. Eginitis.** (Comptes Rendus, 136. pp. 962–964, April 20, 1903.)—It is found that when there is great heating of the electrodes, the luminous effect is small and *vice versâ.* An artificial heating of the electrodes diminishes the luminous effect and *vice versâ.* The magnitude of these variations depends on the self-induction. A critical temperature exists for this phenomenon. J. W. P.

1431. *Action of Radiation on the Electric Spark.* **W. Lébédinsky.** (Journ. de Physique, 2. pp. 249–253, April, 1903.)—Describes certain and simple methods of experiment for showing the double action of ultra-violet rays in the electric spark; these rays under some circumstances helping the sparking and under others opposing it. Radium radiations give practically the same results as ultra-violet rays. With Röntgen rays the first phenomenon is easily obtained; the second could only be observed under the following conditions: A Voss machine gives sparks between two balls, in parallel with this spark-gap is another consisting of two brass discs or a brass cone and disc; this is fed from the same machine through a cotton thread. When the spark in the latter gap, which is very thin and infrequent, is submitted to the action of the Röntgen rays it can be extinguished. E. C. R.

1432. *Potential Distribution in the Kathode Dark Space.* **A. Wehnelt.** (Ann. d. Physik, 10. 3. pp. 542–580, Feb., 1903.)—The author has treated this subject before. [See Abstracts Nos. 1928 (1901) and 828 (1903).] He uses either plane or curved anodes and kathodes and determines potential at various points by fusing into the vacuum tube metal pointed probes guarded by glass tubes except at the end, and connected to electrometers. His conclusions are as follows: (1) The potential change in the dark kathode space has no real maxima and minima. (2) He attributes the maxima and minima which W. P. Graham found [see Abstract No. 898 (1898)] to the bad working of Graham's probes. (3) A. Schuster's interpolation formula, $V_x = V_0 (1 - e^{-kx})$, where x is the distance from the kathode, is found not to be true; for k, instead of being constant, increases greatly as x decreases. (4) The equi-potential surfaces round the kathode are not planes, but are in general of a bulging but symmetrical form. (5) The total free electricity in the dark kathode space round a ball-kathode is positive. P. E. S.

1433. *Kathode-fall for Alkali Metals.* **K. Mey.** (Deutsch. Phys. Gesell., Verh. 5. 3. pp. 72–74, Feb. 15, 1903.)—Warburg has observed that the alkali metals have a small kathode fall of potential. The author works with potassium, sodium, and an alloy of these at ordinary temperatures in nitrogen, hydrogen, and helium. He finds the kathode-fall to be 178 volts for sodium in nitrogen and 69 volts for potassium in helium. These are the extreme values found. In a table he shows that all other metals—silver, platinum, iron, &c., in the same gases have higher voltages. P. E. S.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1434. *Effects of Temperature on Electro-capillary Phenomena.* **Gouy.** (Comptes Rendus, 136. pp. 653–654, March 16, 1903.)—The author paid special attention to the changes in the maximum electro-capillarity with alteration of temperature for equivalent solutions of the following substances: Water; sodium sulphate, nitrite, acetate, and sulphocyanide; potassium carbonate, phosphate, nitrate, iodide, bromide and platinocyanide; ammonium phosphate; sulphuric acid; hydrochloric acid; saccharose; resorcin; caffeine; amygdalin. From the data it appears that for water and feebly active bodies, the maximum diminishes when the temperature increases; the coefficient of diminution is approximately the same for the different bodies examined. Active bodies have a smaller coefficient of diminution of the maximum; very active bodies may even show an increase of the maximum with rise of temperature. D. H. J.

1435. *Electrical Conductivity of Solutions.* **W. C. D. Whetham.** (Roy. Soc., Proc. 71. pp. 332–338, April 7, 1903.)—The experiments on the conductivity of aqueous solutions at the freezing-point of water [see Abstract No. 1890 (1900)] have been extended to higher concentrations. The results are given in the following table :—

Equivalent Conductivities at 0° in Absolute Units.
m = number of Gram-equivalents of Solute per thousand grams of Solution.

m.	$m^{\frac{1}{3}}$.	KCl.	$\frac{1}{2}BaCl_2$.	$\frac{1}{2}K_2Cr_2O_7$.	$\frac{1}{2}CuSO_4$.	$\frac{1}{2}MgSO_4$.
0·00001	0·0215	807	746	813	696	699
0·00002	0·0272	807	746	804	692	694
0·00005	0·0368	807	745	781	684	685
0·0001	0·0464	806	742	763	674	676
0·0002	0·0585	806	739	740	660	663
0·0005	0·0794	803	731	722	633	639
0·001	0·100	800	723	714	602	614
0·002	0·126	796	711	709	563	579
0·005	0·171	787	690	708	500	512
0·01	0·215	776	669	704	445	468
0·02	0·271	761	645	695	388	417
0·03	0·311	752	629	685	357	387
0·05	0·368	740	607	669	326	353
0·10	0·464	723	581	643	282	309
0·20	0·585	705	554	615	243	270
0·40	0·737	692	530	—	205	229
0·50	0·794	690	522	—	192	222
1·0	1·000	690	496	—	160	188
1·2	1·063	694	490	—	152	176
1·5	1·145	—	481	—	145	161
2·0	1·260	—	472	—	135	136
3·0	1·442	—	—	—	—	94·5

T. M. L.

1436. *Electrical Conductivity of Chloral Hydrate Solutions.* **R. De Muynck.** (Annal. Soc. Sci. de Bruxelles, 27. pp. 186–191, April, 1903.)—On passing an alternating current through an aqueous solution of chloral hydrate, the resistance, which is at first about the same as that of distilled water, decreases very rapidly, and apparently indefinitely. This would seem to indicate that molecular dissociation is produced by the current, and experiments made on solutions of chloral and chloral hydrate in water and in 94 per cent. alcohol, using a continuous current, support this view, hydrogen apparently being liberated at the kathode, and chlorine, or a mixture of chlorine and oxygen at the anode, while hydrochloric acid is produced in the liquid. Though special care was taken, however, to purify the substances employed, the author considers it quite possible that these results are due to the action of the current on impurities still remaining. For solutions in toluene a specially sensitive galvanometer is necessary to indicate any current, a difference of potential between the poles of 116 volts showing no electrolysis. Chloral hydrate is found to increase the conductivity of the toluene somewhat, but anhydrous chloral or water added alone, has very little effect, the improved conductivity evidently being due to chloral hydrate as such.

W. H. S.

1437. *Revised Thermo-electric Series and a New Thermo-element.* **A. Heil.** (Zeitschr. Elektrochem. 9. pp. 91-97, Jan. 29, 1903.)—On account of the erroneous character of much of the accepted data the author presents the following table of thermo-electric potentials :—

Cu 60 Ni 40 with

(a) Difference of Temperature = 230° C.			(b) Low Red Heat or Melting-point.		
Bi	— 0·005	volt	Bi at 270° C.	+ 0·002	volt
Na	— 0·004	„	„ 180° C.	— 0·0023	„
Co	+ 0·002	„	Na (metallic surface)	+ 0·004	„
Ni	+ 0·0035	„	„ (oxidised „)	— 0·0035	„
Te-Bi	+ 0·005	„	Pb at 330°	+ 0·009	„
Pb	+ 0·0070	„	Sn „ 228°	+ 0·0093	„
Sn	+ 0·0077	„	H „ 290°	+ 0·0100	„
H	+ 0·0080	„	Cd „ 310°	+ 0·013	„
Magnalium	+ 0·0085	„	Zn „ 430°	+ 0·016	„
Zn	+ 0·0090	„	Co (dark red heat)	+ 0·018	„
Sb2Te1	+ 0·0092	„	Te-Bi at 200°	+ 0·019	„
Al	+ 0·0095	„	Ni (dark red heat)	+ 0·021	„
Mg	+ 0·0097	„	Al	+ 0·024	„
Graphite	+ 0·0098	„	Sb2Te1, about 300°	+ 0·024	„
Pt	+ 0 0098	„	Magnalium, about 500°	+ 0·028	„
Ag	+ 0·0110	„	Magnesium „ „	+ 0·034	„
Brass	+ 0·0112	„	Graphite	+ 0·036	„
Au	+ 0·0113	„	Pt, about 500°	+ 0·037	„
Cu	+ 0·0114	„	Brass „ „	+ 0·039	„
Cd	+ 0·0117	„	Ag „ „	+ 0·0395	„
Fe	+ 0·0128	„	Au „ „	+ 0·0396	„
Sb8Ni1	+ 0·0140	„	Fe „ „	+ 0·0397	„
Ce	+ 0·0168	„	Ce „ „	+ 0·0398	„
Zr	+ 0·0169	„	Cu „ „	+ 0·040	„
Sb	+ 0·0170	„	Zr „ „	+ 0·042	„
Sb122Zn65	+ 0·045	„	Sb „ „	+ 0·052	„
Te	+ 0·049	„	Te „ „	+ 0·113	„
			Sb122Zn65, about 500°	+ 0·130	„

As will be seen, constantan (an alloy of Cu and Ni) and the Sb-Zn alloy are the substances most widely separated in the table, and they are therefore used by the author for the construction of a very efficient new thermo-element, which is described in detail in the paper, but is not yet on the market.

D. H. J.

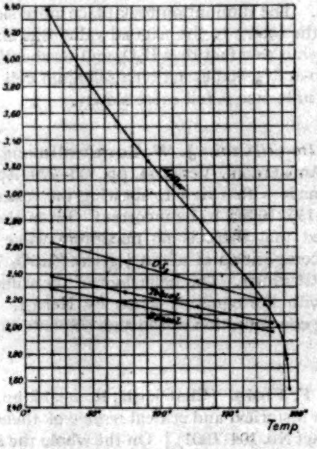
1438. *Action of Radio-active Bodies on the Electric Conductivity of Selenium.* **E. van Aubel.** (Comptes Rendus, 136. pp. 929–930, April 14, 1903.)—It has been proved that radium rays affect the electric conductivity of selenium, the observed diminution of resistance being of the same order of magnitude as that produced by light and by Röntgen rays, but being produced more slowly. In this paper the author describes experiments made to test the effect upon selenium of two bodies recently found to be radio-active—hydrogen peroxide and terebenthene (French turpentine). The selenium cell was placed over a dish filled with water containing 30 per cent. by weight of H_2O_2. A wooden board could be inserted between the dish and the cell, and the whole apparatus was kept screened from light. With the board in position the resistance of the cell was 496,000 ohms, which fell in 3 to 4 minutes to 324,000 ohms when the board was withdrawn. On replacing the board the resistance rose slowly to its first value. A similar experiment with terebenthene in place of H_2O_2 gave a fall of resistance from 461,000 ohms to 386,000 ohms after the cell had been exposed for about 15 minutes to the action of the liquid. The diminution took place more slowly in this case than in the former, and the return to the original value was also more slow. These experiments establish it as a fact that H_2O_2 and terebenthene are radio-active, and show that radio-active bodies act on a selenium cell like light or Röntgen rays, but that their influence is felt more slowly. W. C. H.

1439. *E.M.F. of Daniell Cells.* **J. W. Commelin** and **E. Cohen.** (Konink. Akad. Wetensch. Amsterdam, Versl. 11. pp. 771–779, April 24, 1903.)—These experiments were made with a view to showing the researches by J. Chaudier [see Abstract No. 1155 (1902)] to be incorrect. From the figures given by the author, it is inferred that there is no maximum value of the e.m.f., corresponding with the composition of about ½ gram. $ZnSO_4, 7H_2O$ per 100 grams water, as stated by Chaudier. The behaviour of the values is, on the contrary, in perfect accord with the equation given by Nernst. From this it follows that with increasing concentration of the zinc sulphate the electromotive force diminishes. A. G.

1440. *Coherers.* **F. Piola.** (Elettricista, Rome, 12. pp. 32–38, Feb., 1903.)—The author gives an historical and critical *résumé* of theories, particularly that of Bose. [See Abstract No. 104 (1901).] On the whole the author regards Bose's theory as founded on observed facts and on hypotheses rendered probable by analogies, but thinks the allotropic modifications in the coherer assumed by the theory are not yet capable of direct proof. A. D.

1441. *Bridging over Broken Contacts.* **T. Sundorph.** (Ann. d. Physik, 10. 1. pp. 198–204, Dec. 30, 1902.)—On breaking metallic contact in the circuit of one or two Bunsen cells, and doing this with extreme slowness, the gap is long bridged over by fine wires, sometimes even invisible with a low-power microscope. These present curious movements, and they fall off greatly in conductivity when the current is interrupted. The behaviour of different metals is compared. A. D.

1442. *Change of Dielectric-Constant of Liquids with Temperature.* **K. Tangl.** (Ann. d. Physik, 10. 4. pp. 748–767, March 13, 1903. From a paper read before the Akad. d. Wissensch. May 26, 1902.)—Determinations of the dielectric constants of benzol, toluol, metaxylol, carbon bisulphide, chloroform and ethyl-ether were made between about 20° C. and 190° C. with the object of testing the Mossotti-Clausius formula $(D-1)v/(D+2) = \text{const.}$ (where D = dielectric constant and v = specific volume). With the exception of xylol and chloroform the values obtained for D are shown in the accompanying curves. The curve for chloroform is slightly convex to the origin, its extreme and mean values for D being respectively 4·85, 3·74, 2·94, at 20° C., 100° C., and 180° C. The curve for xylol is a straight line, the extreme values for D being 2·38 at 20° C. and 2·06 at 180° C. The critical temperature of ether only lay within the range covered in these experiments. By slowly varying the temperature this was found to be 193·8. As the curve shows, a rapid diminution of the value of D occurred as the critical temperature was approached. The diminution was found to continue till the temperature was raised to 199° C. [the highest temperature reached] when D became 1·539, but on cooling again D remained constant till the critical temperature was reached, after which it increased again, repeating its previous values after 186° C. Consideration of these results led the author to conclude that a minimum value of D is very nearly reached at 199° C. and that its critical value is 1·533. In order to test the Mossotti-Clausius formula, the values of D for the first five liquids mentioned above were connected with temperature by equations of the usual form $D = D_0(1 + at + \beta t^2 + \&c.)$; D for benzol being given by $D = 2{\cdot}822\,(1 - 0{\cdot}000794t - 0{\cdot}0_6259t^2)$, with a maximum error of ∓ 0·001. The Mossotti-Clausius "constant" was then calculated for egularly increasing temperatures. For xylol the value varied only 0·2 per cent. between 0° C. and 180° C., being 0·3654 at 0° C. In the cases of benzol and carbon-bisulphide the values increased 5·4 per cent. between 0°–200° C., the respective values at 0° C. being 0·3398 and 0·2772. In the case of toluol it diminished 0·6 per cent. between 0°–100° C., and in that of chloroform 4·8 per cent. from 0°–60° C; its values at 0° C. being respectively 0·3659 and 0·3846. Lastly, the value for ether diminished 17 per cent. between 20° C. and its critical temperature 193·3° C., its value at 18° C. being 0·7886. The liquids, after being carefully dried and distilled, were sealed in a cylindric hard glass



tube 16 cm. long and 1·2 cm. inside diameter, containing two coaxial platinum cylinders. The capacity of the condenser so formed, with the liquid as dielectric, was compared with that of a variable standard condenser by Nernst's telephone method. The tube was electrically heated by means of a cylindrical jacket consisting of two concentric cylinders surrounded with asbestos and containing between them a heating coil so disposed as to produce uniformity of temperature. Stirring of the liquid was thus obviated. About two-thirds of the glass tube was surrounded with a mica cylinder wound with platinum wire the resistance of which enabled the temperature of the tube to be estimated. The apparatus was carefully tested, to avoid errors due to inherent variations of the platinum condenser with temperature, before the introduction of the liquids. The thermometric wire was calibrated against a Geissler thermometer. The more recently published work of P. Eversheim should be consulted. [See Abstract No. 160 (1903).]
J. D. C.

1443. *Sparkless Interruption of Currents.* **K. Birkeland.** (Archives des Sciences, 15. pp. 438–442, April, 1903.)—This is a preliminary note upon the possibility of being able to interrupt an electric current with avoidance of sparking injurious to the contact surfaces. All the methods described by the author depend upon connecting an inductive circuit between the contact points. In one arrangement this circuit consists of a hollow bobbin into which a soft iron core is attracted at the moment the current starts in its windings. The counter e.m.f. set up by the approach of the iron to the coil is supposed to be such as to nullify the direct current through the coil, so that complete interruption can, theoretically, be accomplished at that instant without a spark. A more elaborate arrangement is also described, in which the inductive circuit is a transformer, and there is a special mechanical device for effecting the various contacts.
R. A.

1444. *Use of an Electolyte with an Induction Coil.* **Bordier** and **Nogier.** (Archives d'Él. Médicale, 10. pp. 759–763, Dec., 1902.)—A series of jars containing a weak solution of sulphuric acid are connected by plates of lead and placed in shunt in the primary current of a Ruhmkorff coil. When the primary current is interrupted, a polarisation current is developed, which discharges immediately afterwards in the same direction as the primary current. With this arrangement there is a considerable lengthening of the spark, especially when the primary current is of low intensity. The discharge from a Röntgen-ray tube is intensified and steadied, and the efficiency of a high-frequency apparatus is augmented by its use.
H. W. P. Y.

1445. *Aluminium Electrolytic Rectifiers.* **E. König.** (Elektrotechn. Zeitschr. 23. pp. 474–476, May 19, 1902. Paper read before the Naturforschenden Gesellschaft, Bern.)—This article deals exhaustively with the subject of aluminium rectifiers. After an historical introduction, tables are given of the results of tests made. These include the terminal p.d. necessary to drive a given current in one or the opposite direction, the real and apparent watts in the alternating-current circuit, the volts and amperes in the rectified circuit, and the efficiency obtained. The author is not inclined to consider the life of such a cell as a long one, and his results show that with long-continued loads the throttling effect (unidirectional) decreases, and that with decreasing efficiency in the rectified circuit, the real and apparent watts in the alternating-current circuit continually increase. [See also Abstracts Nos. 579 (1899) and 1159 (1901).]
L. H. W.

1446. *Damped Ballistic Galvanometers.* **O. M. Stewart.** (Phys. Rev. 16. pp. 158–165, March, 1903.)—Theory developed. Both in periodic and aperiodic damped ballistic galvanometers the throw is directly proportional to the quantity of electricity suddenly discharged through them. In a well-damped galvanometer the principal agent in limiting the throw is not the earth's field or the torsion of the suspension, but the damping. Where the damping is just sufficient to prevent periodicity ($\lambda^2 = 0$), the throw is independent of changes in the earth's field or suspension, except as those changes make λ not $= 0$; the time of throw is $1/2\pi$ × the period of vibration when there is no damping; and the throw is about 37 per cent. of the undamped throw. Damped D'Arsonval galvanometers are suitable for ballistic work, but though far more convenient are somewhat less sensitive than undamped ballistic galvanometers. A. D.

1447. *Wehnelt Interrupter.* **L. Dall' Oppio.** (N. Cimento, 5. pp. 27–31, Jan., 1903.)—The apparatus described relates to that form of the Wehnelt interrupter in which a rod and a plate, not attacked by the liquid, are separated by glass pierced by a small orifice, and to its use for alternating currents. Through the orifice there runs a stream of air bubbles and liquid, and at the orifice a bubble is rapidly formed and reformed which is luminous, giving the spectrum of water-vapour, and is apparently due to explosions of oxy-hydrogen mixture. This explosion is due to the transport of ions, which vary in number inversely as the section of the bundle of lines of force along which they travel, and to the heat developed locally. In this instrument the interruptions are clearly due to this exploding bubble of oxy-hydrogen mixture. With this interrupter used with alternating currents, the currents pass quasi-equally in both directions, and a focus tube is practically full of light. Deviations from this depend on the conditions of the secondary coil of the Ruhmkorff.

A. D.

1448. *A New Relay.* **A. Trowbridge.** (N. Cimento, 5. pp. 267–272, April, 1903.)—When mercury is made to fall through a small hole into a liquid, if an electric current passes through the mercury and the liquid, the jet changes very much, no matter if the e.m.f. is external or internal (mercury-liquid-mercury). The author experiments with carburet of sodium, when the e.m.f. varies from 0·1 to 0·15 volts, and he constructs an apparatus utilising this property, which acts as a relay. This apparatus seems similar to that of Orling and Armstrong, but in reality is very different from it.

A. F.

1449. *Sensitive Gold-leaf Electrometer.* **C. T. R. Wilson.** (Cambridge Phil. Soc., Proc. 12. pp. 135–139, April, 1903.)—In a brass box 4 cm. × 4 cm. × 3 cm., a gold-leaf 2 mm. wide and 3 cm long is hung from a brass wire. The wire passes through an insulating plug of sulphur in the box, and opposite to it is a brass plate, also insulated by a sulphur plug. Glass windows are on the sides of the box, and the leaf is viewed by a microscope. The insulated plate is kept at a constant potential, variable at will. The electrometer is placed in an inclined position, and it is found by trial that there is a certain critical position of instability as the leaf approaches the plate; the most sensitive position for the leaf is just after the unstable position has been passed. If the instrument is to be carried about without risk, the insulated plate is highly charged and then the gold-leaf stretches itself straight towards, but without touching, it. One-third of a volt can be read on the instrument. P. E. S.

1450. *Portable Capillary Electrometer.* **S. W. J. Smith.** (Phil. Mag. 5. pp. 398–404, April, 1903. Communicated by the Physical Society.)—In an old form of this instrument there were two vertical wide glass tubes joined at their middles by a horizontal capillary glass tube. One tube contained mercury and the other mercury and dilute sulphuric acid, the junction of mercury in one tube and acid in the other being midway in the capillary tube. The two separated masses of mercury were placed at the given p.d. by means of platinum wires fused into the tubes. In the new form, which is somewhat more complex, are the following changes: (1) The wide tubes are closed at the top to the outer air, but joined together by a tube; (2) there is a junction tube at the bottoms of the tubes; (3) in place of the old tapping key there is a mercury key, a pneumatic ball is pressed, thus driving mercury in a U-tube from one set of contacts to another; (4) in place of the usual forms of commutator there is a mercury one similar in principle to the mercury key. The advantages claimed for these mercury keys are that there is no thermo-electric action and no danger of contact surfaces being dirty. P. E. S.

1451. *Chord Galvanometer and the Human Electrocardiogram.* **W. Einthoven.** (Konink. Akad. Wetensch. Amsterdam, Versl. 12. pp. 122–131, June 27, 1903.)—In a previous paper the author had indicated the principle of a novel galvanometer made up of a silvered quartz thread, stretched like a chord in a strong magnetic field. [See Abstract No. 1364 (1902).] As soon as an electric current is led through the thread, the latter will diverge at right angles to the direction of the magnetic flux, the amount of deflection being directly measured by means of a microscope with an eyepiece micrometer. Some important improvements in the instrument have recently been made enabling the chord (a quartz thread 2·4μ in thickness and 10,000 ohms in resistance) to be stretched more strongly. Under certain circumstances, currents not higher than 10–12 amperes may be detected by the instrument. The thread may be stretched just sufficiently to have a current of a given strength produce a deflection determined beforehand. The image of the middle of the thread, after being magnified 660 times, is thrown on a slit perpendicular to the image of the thread. In front of the slit there is a cylindrical lens, the axis of which is parallel to the slit, while behind there is a photographic plate moved in the direction of the image of the chord. At the same time a system of coordinates is projected on the sensitive plate according to Garten's method, where the horizontal lines are obtained by a glass millimetre scale, placed immediately in front of the sensitive plate, so that the sharp shadows of the division are projected on the plate, whereas the vertical lines are due to the spokes of a disc rotating uniformly, intercepting intermittently the light falling on the slit. From the photographic diagrams thus obtained, it is inferred that the deflections, being aperiodic, are accurately proportional to the intensities of the current. This instrument is applied by the author to determining the human *electrocardiogram* discovered by A. D. Waller (Phil. Transactions, vol. 180, B. pp. 169, 1899). It is interesting to note the constancy in the form of this curve for a given person, the alterations occurring in the course of time being so small as to enable one with a little practice to recognise many persons by their electrocardiograms. A. G.

ALTERNATING CURRENTS AND MAGNETISM.

1452. *Frequency of Alternating Currents.* **G. Vanni.** (Elettricista, Rome, 12. pp. 29–31, Feb., 1903.)—A method of measurement based on reflecting a beam of light from a galvanometer needle oscillating aperiodically under the impulses of the alternating currents, and receiving the beam on a mirror attached to an adjustable tuning-fork; then adjusting the tuning-fork till the Lissajous' figure produced shows isochronism (straight line, circle, ellipse); the slightest variation in the frequency induces instability in the Lissajous' figure obtained. Another method, based upon the projection through a stroboscopic disc of a beam of light reflected from the mercury meniscus in a Lippmann capillary electrometer, the oscillations of which meniscus soon become aperiodic; when the beam passed through the stroboscopic disc appears steady upon a screen, the number of interruptions indicates the frequency of the alternating current, and the number of interruptions is ascertained by an acoustic method, involving the observation of beats. Both methods are very exact and practically applicable. A. D.

1453. *Frequency of Alternating Currents.* **G. Sartori.** (Elettricista, Rome, 12. pp. 87–88, April, 1903.)—The frequency is adjusted by varying it until the current on being passed through a determinate stretched wire induces resonance in that wire, with ample vibrations. When the frequency varies the sound dies down. A. D.

1454. *Propagation of Magnetic Waves in Iron Cylinders.* **J. Zenneck.** (Ann. d. Physik, 10. 4. pp. 845–852, March 13, 1903.) In a former paper [see Abstract No. 742 (1903)] the author developed the idea of magnetic inductance, and applied it to several problems. He now uses it to investigate the propagation of magnetic waves in iron cylinders. Hysteresis and the component of induction at right angles to the cylinder axis are neglected, and on this account the results are only in qualitative agreement with observation. W. S.

1455. *Magnetic Shielding due to Hollow Iron Cylinders.* **J. Russell.** (Roy. Soc., Edinburgh, Trans. 40. 3. pp. 631–681, April 21, 1903.)—A uniform field is obtained, as in a Helmholtz galvanometer, by two large parallel coils whose distance apart is about equal to their radius. At the centre of the system is a pivoted inductor of fine wire so arranged that when a catch is removed an elastic band causes the inductor to rotate 180°. The inductor is connected to a ballistic galvanometer. Surrounding the inductor is a shielding cylinder of iron. If the cylinder is removed the field measured by the inductor is called the transverse field, and when the shield is in position the field measured by the inductor is called the internal field. The ratio of transverse to internal field is called the shielding ratio. The theoretical formulæ for shielding assume that permeability is constant all round the cylinder, and that retentivity is absent. Using a *transverse* field, if the field be increased by increments from zero, it is found that shielding ratio minus unity is proportional to B/H; but if the field be decreased from a maximum, these conditions are not fulfilled, since the shielding ratio follows a kind of hysteresis curve, on account of retentivity. When, in addition to a *transverse* field, a *circular* field is applied by winding a coil on the cylinder, the shielding ratio depends on the order and manner in which one field is applied on the other. The results do not confirm those of Du Bois [see Abstract No. 954 (1898)]. It is found that repeated reversal of the transverse field increases the permeability for the constant circular field and lowers that for the transverse field itself. One part of the paper deals with magnetic induction due to superposition of fields, and B-H cycles are traced for various cases. During the early stages of induction the experiments show that iron is more permeable to a reapplication of a magnetising force than to a force at right angles to that used previously; but this difference vanishes as magnetising force increases. P. E. S.

1456. *Magnetic Hysteresis at High Frequencies.* **C. E. Guye** and **B. Herzfeld.** (Comptes Rendus, 136. pp. 957–959, April 20, 1903.)—Divergence of opinion exists as to whether the energy dissipated in a cycle varies with the frequency. Foucault currents obscure the result. The authors employ very fine iron wires to avoid this, *e.g.*, a wire of diameter 0·374 mm.; and they conclude that the power absorbed is independent of the frequency. Frequencies up to 1,200 per second are used. J. W. P.

1457. *Magnetic Properties of the Terrestrial Atmosphere.* **C. Nordmann.** (Comptes Rendus, 136. pp. 960–962, April 20, 1903.)—Faraday's qualitative theory that the varying magnetisation of the atmosphere due to sun-heat is responsible for the diurnal variation of the magnetic needle is here put to the quantitative test. The effect is concluded to be (from data of other experimenters) quite infinitesimal, and cannot account for the diurnal variations. J. W. P

1458. *Magnetic Anomalies on the Puy de Dôme.* **B. Brunhes** and **P. David.** (Soc. Franc. Phys., Séances, 1. pp. 56–59, 1903.)—Many observations made by the authors on the top of the Puy de Dôme, show that the declination varies by more than 7°, between 12° and 19° approximately, within a distance of 150 m., and the horizontal component between 0·198 and 0·225 c.g.s. within a distance of 250 m. The top of the mount is crowned by a tower, and within 25 m. of this tower the values of the elements were most irregular. The inclination could be determined in a few spots only. The mountain behaves like a north pole. H. B.

1459. *Solar Prominences and Terrestrial Magnetism.* **N. Lockyer** and **W. J. S. Lockyer.** (Roy. Soc., Proc. 71. pp. 244–250, March, 1903.)—This communication gives further details supplementary to a former paper. [See Abstract No. 291 (1903).] The prominences on the sun's limb (Tacchini's observations) are divided into zones of 10° or 20° of latitude. In the lower latitudes the sun-spot and prominence curves agree; in higher latitudes the prominence curves display subsidiary changes of curvature superimposed on the main sun-spot curve; above latitude 60° outbursts of prominences are rare. That the curves indicating the variations from year to year in the diurnal range of magnetic declination and horizontal force are similar to the sun-spot curves had already been shown by W. Ellis. The authors find, further, that magnetic disturbances occur at the same times as prominences, and also when the sun-spot curve is approaching a maximum and at the dates of the widened line crossings, namely, when the curve representing the "unknown" lines is on the rise, and traverses the "known" line which is descending—not in the opposite case. Reference is made to the analogies pointed out by Bigelow. H. B.

ELECTROPHYSIOLOGY AND ELECTROTHERAPEUTICS.

1460. *Animal Thermostat.* **A. Chauveau.** (Comptes Rendus, 136. pp. 847–852, April 6, 1903.)—A further reply to Kelvin's communication. [See Abstracts Nos. 1215 and 1216 (1903).] The fact that the animal body possesses means of defence against excessive external heat was known to and studied by Franklin and Delaroche. These are the phenomena of cutaneous and pulmonary evaporation. Their power is extremely limited. One hour in a stove maintained at 39° C., the normal temperature of the animal, is sufficient to raise the temperature of a guinea-pig 4° above that of the stove. The processes of combustion in the tissues, and the production of heat cannot cease, much less can deoxydation take place, since the former have not for their sole or even most important object the maintenance and regulation of the temperature of the animal body, but are essential to the physiological activity of the cells. Heat is but the final product in the expenditure of energy essential to metabolism, and thermogenesis must therefore continue as long as life is maintained. H. W. P. Y.

1461. *Effect of High-frequency Currents on Animals.* **H. Bordier** and **Lecomte.** (Archives d'Él. Médicale, 11. pp. 129–135, March, 1903.)—A high-frequency current of 400 milliamperes intensity applied directly to rabbits and guinea-pigs caused tetanisation, arrest of respiration, and, finally, death in from eight to twenty minutes. The direct application of the same current to man cannot be felt. The authors consider that their experiments disprove the statement of some observers that high-frequency currents do not penetrate the organism, but flow over the surface of the body. H. W. P. Y.

1462. *Electric Currents in Nerves.* **N. E. Wedensky.** (Comptes Rendus, 135. pp. 804–806, Nov. 10, 1902.)—Theory, developed in outline, which reconciles many anomalies of the nerve-current. There may be total parabiosis (insensibility and non-conductivity) induced by narcosis or by sufficient chemical, thermic or electric stimulation ; and the parabiosic part of the nerve is negative to the normal parts of the same nerve. If the parabiosis be incomplete, we have intermediary conditions ; and before the affected part regains its normal condition, it becomes feebly positive to the normal parts. Parabiosis is a condition very refractory to external stimulation, and the local negativity of the nerve, with its corresponding currents, persists and modifies tetanising currents, for example. A. D.

1463. *Electromotive Force in Plants.* **A. B. Plowman.** (Amer. Journ. Sci. 15. pp. 94–104, Feb., 1903.)—The functional activities of a plant give rise to differences of electric potential in its parts, which depend upon the physiological condition and the electrical conductivity. The normal e.m.f. may be modified in intensity or direction by brief application of forced currents, partly on account of a change in resistance and partly through a modification in the vital activity of the protoplasm. Slight mechanical injuries do not perceptibly modify the normal current ; extensive mechanical injuries or high temperatures destroy it, but do not modify the reaction current except by a slight increase in the conductivity of the tissues. Extensive injuries create an e.m.f. spreading from the point of injury through the tissues. Reaction-currents depend little, if at all, upon the vitality of the plant, and can be duplicated in non-living substances. Burdon-Sanderson's and the author's results are explained on the basis of physical chemistry. A. D.

REFERENCES.

1464. *Conducting Networks.* **L. R. Wilberforce.** (Phil. Mag. 5. pp. 489-490, April, 1903. Paper communicated by the Physical Society, read Jan. 23, 1903.)—The author establishes the well-known reciprocal relations between the parts of a conducting network by the use of Ohm's Law and in a simple manner without an appeal to the properties of determinants. E. C. R.

1465. *Theory of Electrons.* **H. A. Lorentz.** (Konink. Akad. Wetensch. Amsterdam, Versl. 11. pp. 729-747, March 28, 1903.)—The following points are successively treated in this paper: Introduction of new units in the fundamental equation; Scalar potentials and vector potentials; propositions corresponding with d'Alembert's principle and the principle of minimum effect and ponderomotive effects on a system of electrons. [See also Abstract No. 245 (1903).] A. G.

1466. *Electrons.* **O. Lodge.** (Inst. Elect. Engin., Journ. 32. pp. 45-116, Feb., 1903.)—In this paper the author gives a lucid and connected exposition of the electron theory and its application to the explanation of various physical phenomena. G. W. DE T.

1467. *Spiral Lightning.* **F. Klingelfuss.** (Ann. d. Physik, 10. 1. pp. 222-224, Dec. 30, 1902.)—An illustrated account with photograph of a very unusual spiral or "whirlwind" discharge of electricity which occurred over the town of Basel on July 15, 1902. D. H. J.

1468. *Holtz Machine Experiments.* **K. R. Johnson.** (Phys. Zeitschr. 4. pp. 298-302, Feb. 15, 1903.)—Under high frequencies, electrolytes have scarcely any conductivity, and sparks through gases do not meet with a true Ohmic resistance. A. D.

1469. *Sparking Potential and Spark Length in Air at Atmospheric Pressure.* **M. Toepler.** (Ann. d. Physik, 10. 4. pp. 730-747, March 13, 1903.)—A continuation of the author's previous work. [See Abstract No. 1349 (1902).] R. S. W.

1470. *Electric Calibration of a Conducting Wire.* **G. di Ciommo.** (N. Cimento, 5. pp. 90-108, Feb., 1903.)—The author describes a method for somewhat simplifying calculations by the use of auxiliary resistances. A. D.

1471. *Glass for Electrical Purposes.* **E. Boistel.** (Ind. Élect. 12. pp. 125-131, March 25, 1903.)—The use of glass for insulating purposes is discussed. The article contains several tables of value. G. W. DE T.

1472. *Portable Resistances.* **E. Orlich.** (Zeitschr. Instrumentenk., Beib. 8. pp. 65-67, April 15, 1903.) A. D.

1473. *Resistances for Moving Coil Galvanometers.* **W. Volkmann.** (Ann. d. Physik, 10. 1. pp. 217-221, Dec. 30, 1902.)—The author describes a simple subsidiary resistance-box for use with moving coil galvanometers so as to facilitate an easy regulation of the sensibility of the galvanometer without alteration of the damping or circuit-resistance. D. H. J.

1474. *Current Interrupters.* **M. Aliamet.** (Électricien, 25. pp. 209-212, April 4, 1903.)—This is a description of various modifications of interrupters for induction coils. In principle they all resemble the "Vril" interrupter, the break being rendered abrupt by checking the vibrating piece by an obstacle placed near the middle of its path. R. A.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1475. *Nucleation during Cold Weather.* **C. Barus.** (Phys. Rev. 16. pp. 193–198, April, 1903.)—A continuation of the experiments described in Abstract No. 847 (1903). So far the experiments are only qualitative, as further study of the subject and changes in the apparatus will be required before absolute quantitative measurements can be made. One general result now obtained is that a maximum of nucleation frequently occurs contemporaneously with a sudden fall of atmospheric temperature, often associated with northerly winds. If it be supposed that nuclei of any kind are loaded with water by the fall of temperature, there may result an accelerated precipitation of an atmospheric layer of excessive nuclei overhanging cities, produced by the full combustion. Secondly, if water nuclei, thus produced by fall of temperature, are radio-active, they will themselves produce fresh nuclei, and an increase should be observable. In this case the conditions of high nucleation must be shown to correspond to conditions specially favourable to radio-activity, for which there is no evidence, but the author hopes to settle the point by the direct experiments he is now making. W. C. H.

1476. *Carbon Monoxide produced by the Bunsen Burner.* **T. E. Thorpe.** (Chem. Soc., Journ. 83. and 84. pp. 318–319, March, 1903.)—When a Bunsen flame impinges upon a metal surface carbon monoxide is produced, and the object of these experiments is to determine the quantitative relations. It is found that if coal gas be assumed to yield half its volume of carbon dioxide when completely burned, then 0·022 cub. ft. of carbon monoxide is produced per hour by a burner emitting gas at the rate of 6 cub. ft. per hour under 0·95 in. pressure. J. W. P.

1477. *Saponin Froth.* **J. v. Zawidzki.** (Zeitschr. Phys. Chem. 42. pp. 612–616, Feb., 1903.)—The author finds that the froth from an aqueous solution of saponin contains a higher percentage of saponin than the mother liquor; this is in accordance with his previous observation that saponin may be removed from a solution by continually separating the froth which forms during shaking. Plateau has already proved that the viscosity of a surface film is greater and the vapour pressure less than in the saponin solution itself. Quite similar facts may be proved for albumen solutions. D. H. J.

1478. *Compounds of Sulphur Dioxide with Salts.* **P. Walden** and **M. Centnerszwer.** (Zeitschr. Phys. Chem. 42. pp. 432–468, Jan., 1903.)—The vapour pressure of sulphur dioxide is lowered by the addition of potassium iodide, but reaches a steady minimum value at 20 mols. per cent. KI, when the vapour pressure at 0° is 49·9 cm. of mercury. No further reduction of vapour pressure occurs at 50 mols. per cent., and the compound KI, SO_2 does not appear to exist. The melting-point of sulphur dioxide is $-72·7°$, and the melting-point curve reproduced in Figure 1, shows (1) an eutectic point at 0·336 mols. per cent. KI; (2) a maximum melting-point at $-23·4°$, indicating the formation of a compound which separates in yellow crystals, and has probably the formula $KI, 14SO_2$; (3) an eutectic point at which two additive compounds are in equilibrium with the liquid; (4) the melting-point at

+ 0·26° of the compound $KI, 4SO_2$, the existence of which was indicated by the vapour-pressure measurements. The horizontal line represents the temperature at which the mass becomes completely solid, and not the temperature at which the liquid first begins to deposit crystals; it is thus merely a horizontal line drawn through the eutectic temperature for KI and $KI, 4SO_2$; but as KI is insoluble in fused $KI, 4SO_2$, this is identical with the melting-point of the additive compound; the true melting-point curve should run up steeply, as indicated by the ascending line, from 0·26° to the melting-point of potassium iodide. The melted compound is a good conductor, and has $\kappa = 0{\cdot}0494$ reciprocal ohms at 0°. At high temperatures potassium iodide again becomes almost insoluble in sulphur dioxide. The temperature at which solid separates on raising the temperature is shown by the curve ABCD in Fig. 2. Mixtures containing from about 2 to 24 per cent. KI do not at once deposit solid, but separate into two liquid layers at the temperature indicated by the line BEC; but on reaching the temperature indicated by the straight line BC, one of the liquid layers disappears and crystals are formed in its place. The minimum temperature at which two liquid layers can be produced is 77·3°, and the critical composition is 12 per cent. KI. The nature of the liquid phase was not determined, but it is probably not the fused compound $KI, 4SO_2$. Freezing-point determinations showed that in N/10 aqueous solution there is scarcely any association of sulphur dioxide with potassium iodide or sulphocyanide, the depression of the freezing-point by the mixture of substances being but little less than the sum of the depressions produced by the constituents separately. The solubility of sulphur dioxide in water at 25° is 0·0856 g. or 32·76 c.c. per gram of water, and is increased by the presence of salts; the increment of solubility decreases in the series RbI, NMe_4I, KI, KCNS, KBr, $C_6H_4(OH)_2$, KCl, and is negative in the case of NaCl, which produces a slight lowering in the solubility. The solutions have the same colour as solutions in liquid sulphur dioxide—the iodides yellow, the sulphocyanides greenish, and the chlorides and bromides nearly colourless. There is thus clear evidence that sulphur dioxide, like water and ammonia, forms additive compounds with salts, and that these persist in solution; it is proposed to call these "sulphones." [See also Abstract No. 752 (1908).]

T. M. L.

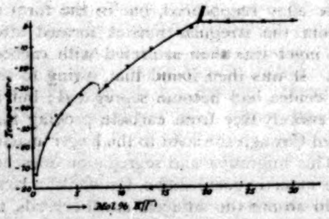


FIG. 1.—Melting-point curve for $KI + SO_2$.

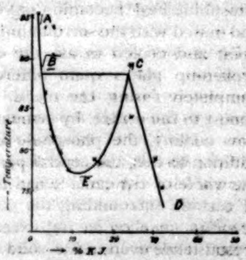


FIG. 2.—Solubility of KI in SO at high temperatures.

1479. *Velocity of Flow of Metals.* **N. Werigin, J. Lewkojeff,** and **G. Tammann.** (Ann. d. Physik, 10. 3. pp. 647–654, Feb., 1903.)—The authors, using the method already described by one of them [see Abstract No. 859

(1902)], have determined the velocity of flow of the following metals at different temperatures: K, Na, Pb, Tl, Sn, Bi, Cd, Zn, Sb. The metals are here arranged in what is found to be the order of diminishing velocity of flow, and therefore in the order of diminishing plasticity or of increasing viscosity. The chief generalisation from the authors' data may be stated thus: At equal pressures, and with the same orifice for the efflux of the metal, an increase of temperature of 10° practically doubles the velocity of flow.

D. H. J.

1480. *Segregatory and Migratory Habit of Solids in Alloys and in Steel below the Critical Points.* **J. E. Stead.** (Soc. Chem. Ind., Journ. 22. pp. 340–346, March 31, 1903.)—An ingot of iron containing 2 per cent. of phosphorus and a little carbon, when cooled moderately quickly, showed the eutectic alloy of phosphide of iron and phosphoferrite in honeycombed forms between the octahedral skeletons of the ground-mass, each patch of eutectic being enveloped by a fringe of pearlite. When annealed in iron ore and cooled very slowly below the eutectic-point, the eutectic alloy entirely disappeared, the phosphide Fe_3P becoming segregated into flat plates, whilst the phosphoferrite had united with the surrounding metal. When again heated above the eutectic point and cooled in air, the eutectic alloy reappeared, but in the form of broken-up plates quite different from the irregular masses formed after completely fusing the metal. The ingot was then saturated with carbon, almost to the centre, by cementation. It was then found that, owing to the slow cooling, the phosphide in the centre had become segregated; but in addition to this, the central part was entirely free from carbide, proving that the whole of the carbide had migrated through the solid to the larger masses of carbide surrounding the core. This migration and segregation does not occur in an alloy having exactly the eutectic composition, for whilst a large crystal tends even in the solid state to absorb the adjacent small crystals, no such tendency exists in a uniform mass of small crystals such as that of which an eutectic alloy consists; the presence of an excess of either constituent is, however, sufficient to bring about segregation. The extent to which small crystals tend to become absorbed by larger masses is illustrated by the case of a piece of soft iron annealed for several years at a suitable temperature, in which the average volume of the crystal particles had increased in the ratio of 1:4,000,000. Similar segregation occurs in the secondary eutectics, such as pearlite, which are formed, not by crystallisation from the liquid state, but by a change in crystalline form of the solid metal. The tendency of pearlite to segregate into its constituents cementite and ferrite is greatest when the proportion of pearlite is less than 5 per cent., and is then frequently complete, the whole of the ferrite of the eutectic being absorbed by the ground-mass of the same material. So also, when there is a considerable excess of cementite, this absorbs the cementite of the eutectic, leaving broad masses of free ferrite in its place. Segregation is very partial when there is between 10 and 50 per cent. of pearlite, and an alloy consisting of pearlite only undergoes local segregation, the particles of cementite being changed from plates into granules, but remaining equally distributed. The segregation is most rapid immediately below the critical point Ar, at 690° C., but continues over a range of about 100 degrees of temperature below this.

T. M. L.

1481. *Spontaneous Decarburisation of Steel.* **G. Belloc.** (Comptes Rendus, 136. pp. 500–501, Feb. 23, 1903.)—The transition-temperature of steel is gradually altered owing to elimination of carbon when it is rapidly heated above 800°, whether the heating is carried out in a porcelain tube or by means of an electric current in a vacuum or in an atmosphere of hydrogen. No change is produced, however, if the occluded gases are driven out by a preliminary heating below 550°, and a gradual heating is thus without effect on the steel. [See also Abstracts Nos. 2217 (1900) and 876 (1902).]

T. M. L.

1482. *Theory of the Tempering of Steel.* **A. Le Chatelier.** (Comptes Rendus, 136. pp. 664–667, March 16, 1903.)—The author emphasises the existence of internal tensions in tempered steel, and states his theory that the tensions are due to changes of volume accompanying changes of allotropic condition produced during the tempering. D. H. J.

1483. *Copper-Cadmium Alloys.* **P. Denso.** (Zeitschr. Elektrochem. 9. pp. 135–137, Feb. 12, 1903. From the Elektrochem. Lab. der Techn. Hochschule, Dresden.)—Copper-cadmium alloys were prepared containing 1, 2·5, 5 and 10 per cent. Cu. These were cast into plates and used as anodes in a solution of cadmium sulphate, with a low current density. The crystals left on the surface of the anode contained 83·5, 84·6, 84·3 and 85·5 per cent. Cd respectively, and evidently consisted of the compound $CuCd_3$ which requires 84·15 per cent. Cd. With a higher current density, the cadmium was dissolved from these crystals, leaving a residue of copper. The cadmium begins to distil from the alloy before its melting-point is reached. T. M. L.

1484. *New Vapour Density Apparatus.* **J. S. Lumsden.** (Chem. Soc., Journ. 83. and 84. pp. 342–351, March, 1903.)—In general principle this resembles the well-known V. Meyer apparatus; but the great difference lies in the estimation of the volume of vapour generated not directly, as in Meyer's form, but by the pressure produced in a mercury manometer. There are other useful modifications of the Meyer apparatus. For high temperatures melting lead is used for the hot bath. The author suggests in another paper that the above apparatus can be used as a pyrometer, since the pressure exerted by a given volume of gas varies as the absolute temperature. P. E. S.

1485. *Cryoscopy of Naphthols.* **K. Auwers.** (Zeitschr. Phys. Chem. 42. pp. 629–631, Feb., 1903.)—The cryoscopic behaviour of the following substances has been examined in *p*-dibrombenzene solution, viz., α and β naphthol, *p*-nitro-α-naphthol, β-nitro-α-naphthol, α-nitro-β-naphthol. There does not appear to be any marked difference between α and β-naphthols. An ortho-nitro group exerts no special influence, but a para- group leads to anomalous cryoscopic results, just as in the case of the monocyclic phenols.

D. H. J.

1486. *Reactions of Liquid Fluorine at −187°.* **H. Moissan** and **J. Dewar.** (Comptes Rendus, 136. pp. 785–788, March 30, 1903.)—For an experiment the substance to be studied was cooled in a small dry sealed tube; the latter was then broken after introduction into the liquid fluorine. It was found that the chemical energy of liquid fluorine at −187° was still sufficiently great to cause combustion of S, Se, P, As, violent decomposition of lime and explosion of anthracene. D. H. J.

1487. *Hydraulic or Estrich Gypsum.* **J. H. van't Hoff** and **G. Just.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 12. pp. 249–258, Feb. 26, 1903.)—

Hydraulic or Estrich gypsum is an anhydrous calcium sulphate which sets much more slowly than ordinary plaster of Paris containing half a molecule of water of crystallisation; it is, however, not identical with natural anhydrite nor with dead-burnt gypsum, since neither of these possesses any setting power. It was found that gypsum completely dehydrated at 100° set even more rapidly than ordinary plaster, but that the rate of setting became steadily less as the temperature was raised; the last half-molecule of water cannot, however, be removed rapidly below 190°, and this is the minimum temperature for the preparation of hydraulic gypsum. The setting is accompanied by a contraction in volume, and can be followed quantitatively by means of a dilatometer; by this method it was found that the proportion converted into dihydrate was 92 per cent. in 23¼ hours in a plaster dried at 200°, but only 56 per cent. in 21 hours in a plaster dried at 300°. Drying at 400° reduced the setting power of a commercial hydraulic gypsum from 67 per cent. in 13 days to 39 per cent., and ignition in a platinum crucible converted it into dead-burnt plaster or anhydrite. The loss of setting power is much slower when the anhydrous sulphate is prepared from a well crystallised half-hydrate.

T. M. L.

1488. *Velocity of Reaction between Diphenyl Iodonium Iodide and Chloride.* **E. H. Büchner.** (Konink. Akad. Wetensch. Amsterdam, Versl. 11. pp. 700–705, March 28, 1903.)—From experiments, it is inferred that the mutual reaction of iodonium haloids is likely to take place between two molecules. Traces of iodine are found to retard the action in an ever increasing degree.

A. G.

1489. *Dissociation and Crystallisation from Solid Solutions.* **C. A. Lobry de Bruyn** and **C. L. Jungius.** (Konink. Akad. Wetensch. Amsterdam, Versl. 11. pp. 698–700, March 28, 1903.)—The analogy between liquid and solid solutions is once more evidenced by the phenomena consideration of which is resumed in this paper. These phenomena are relative to the interesting intermolecular atomic transposition by which *o*-nitrobenzaldehyde in the solid or dissolved state will, under the influence of the blue rays of sunlight, be converted into *o*-nitrosobenzoic acid, one atom of oxygen thus passing from the nitro group to the neighbouring aldehyde group, oxydising the same to carboxyl. Now the authors show that the same transposition takes place in the solid state, this being evidenced by the colour changes undergone by crystals. In some cases they were able to demonstrate the depolymerisation by cryoscopic means; the lowering of the freezing-point is found gradually to increase, while the colour augments in intensity. Uncoloured solid nitroso-bodies were thus found to contain two combined molecules, the intense colouring being due to the isolated molecule. The maximum solubility of *o*-nitrosobenzoic acid in *o*-nitrobenzaldehyde was further determined in the course of this investigation, and the conclusion drawn that both bodies are capable of forming mixture crystals to within 2·6 molecules per cent. of the latter.

A. G.

1490. *Reversibility of Molecular Movements.* **A. Pannekoek.** (Konink. Akad. Wetensch. Amsterdam, Versl. 12. pp. 63–69, May 30, 1903.)—The possibility of a mechanical explanation of Nature is first considered in this paper. In mechanics the movements either of concrete particles or of continuous masses are described. The question as to whether all the natural phenomena may be accounted for by means of similar movements seems to be solved in a negative sense by the irreversibility of natural phenomena, the existence of variations occurring in one determined direction only. According to Poincaré, the second law of thermodynamics, for instance, would wholly exclude the possibility of a similar interpretation of Nature. The author shows that the irreversibility of natural phenomena does by no means exclude the possibility of a similar interpretation, as a mechanical description may be given of a typically irreversible process. This is shown to be the case with mechanically reversible processes with high frequencies, where small variations in the determining component elements give rise to great variations of the resulting element, when the entire process shows the behaviour of a non-reversible process. A. G.

1491. *Hydration and Hardening Phenomena of Some Sulphates.* **P. Rohland.** (Zeitschr. Anorg. Chem. 86. 2. pp. 201–205, May 21, 1908.)—The author has given in a previous paper the characteristic signs of a hydration reaction, where a water-molecule takes an active part, the rate of reaction being affected by fluctuations in the temperature to a much greater extent than with most other reactions. If the substance be present in the solid state, a previous solution has to take place. These reactions are spontaneous phenomena, both positive and negative catalysers being capable of altering the rate of reaction. Some hydration reactions are attended by hardening phenomena, converting some of these substances into states practically insoluble in water. A relation between both phenomena may be shown in the case of metallic sulphates, the temperature playing an important part. By means of Gibbs's phase rule it may be inferred that such sulphates as show a multiple point are capable both of hydration and hardening reactions. This point is at least a quadruple point, being characterised by a transformation phenomenon occurring at a definite temperature. These sulphates are capable of such reactions only below this point, a convenient expression being afforded by Zulkowski's experiments. Catalysers will not show the same action in the case of different sulphates, the influence being either accelerating or retarding. In order to arrive at the conversion point two methods may be followed, as this point may be reached either by heating the sulphates at a given constant temperature, or by making them unite at a fixed temperature, by separating water from their components. The author finally discusses some interesting dehydration phenomena. A. G.

1492. *Mutual Action between Boric Acid, Potassium Fluoride, and Hydrofluoric Acid.* **R. Abegg** and **W. Herz.** (Zeitschr. Anorg. Chem. 85. 2. pp. 129–148, May 21, 1908.)—The results of the experiments recorded in this paper show evidence of a mutual action between H_3BO_3 and H_2F_2, a momentary reversible addition taking place in all cases, which results in a monavalent complex anion being formed. With KF and H_2F_2, however, these anions seem to be different. The products of these reversible reactions afford the starting-point for a second slow and irreversible reaction, as shown by the fact that mixtures of KF and H_3BO_3, though containing the material necessary to form KBF_4, do not produce any appreciable amounts of this during the observations. A most remarkable feature is the slowness and difficulty with which these reactions take place as compared with the general behaviour of inorganic bodies. In investigating the irreversible reaction of H_2F_2 with H_3BO_3, the interesting result was arrived at that, in the case of materially different hypotheses respecting the reaction equation, constants of practically equal suitability may be derived from the rate of reaction, a whole series of other measurement being required in order to explain the nature of such reaction. The authors do not think it improbable that several irreversible reactions may take place simultaneously, further evidence being anticipated from physico-chemical methods. A. G.

1493. *Constant b of van der Waals' Formula.* **J. J. van Laar.** (Konink. Akad. Wetensch. Amsterdam, Versl. 11. pp. 718–729, March 28, 1903.)—Van der Waals, as is known, has derived a new state equation for a simple body, making use of the theory of cyclic movements, the magnitude of the molecule proving variable in terms of the volume. The equation in its new form is tested by the author for the case of a diatomic gas, hydrogen being chosen, when only small departures between the experimental and calculated values were found. In the case of a monatomic gas, such as, for instance, mercury vapour, argon, &c., the coefficient b in $v-b$ should, according to van der Waals' new theory, be invariable, whereas, according to the author, this quantity, though for very great volumes equal to four times the molecular volume, is found to be much smaller for smaller volumes, approaching a value which is twice the molecular volume. A. G.

1494. *Action of Iodine on Alkalies.* **F. Foerster** and **K. Gyr.** (Zeitschr. Elektrochem. 9. pp. 1–10, Jan. 1, 1903. From the Elektrochemisches Laboratorium der Technischen Hochschule, Dresden.)—The first action of iodine on alkalies is the formation of an hypoiodite, giving rise to the equilibrium $I_2 + OH' = HOI + I'$. With excess of alkali, equilibrium exists between the hypoiodous acid and the hypoiodite : $HOI + OH' = IO' + H_2O$. According to the first reaction, free iodine can exist in the presence of free alkali, and this was proved by the authors, both directly and by the fact that addition of potassium iodide to a solution of hypoiodous acid liberates free iodine. Hypoiodous acid is probably weaker than hypochlorous acid. Hypoiodites in solution gradually change into iodates, according to the equation $KOI + 2HOI = KIO_3 + 2HI$. The formation of iodate takes place quicker than the formation of chlorate ; the reaction is accelerated by rise in temperature, by increase in the concentration of the potassium iodide, and also by diminution of the quantity of free alkali present. The disappearance of the free hypoiodous acid, due to the formation of iodate, is accompanied by the disappearance of the free iodine, since the latter is in equilibrium with the former. By the action of neutral oxidisers, such as oxygen, hydrogen peroxide, &c., on solutions of potassium iodide, free alkali is formed as well as free iodine, and therefore some hypoiodite must be produced at the same time. [See also Abstract No. 948 (1903).] T. S. P.

1495. *Decomposition-Temperature of Hydrated Mixed Crystals.* **R. Hollmann.** (Zeitschr. Phys. Chem. 42. pp. 597–600, Feb., 1903.)—If mixed crystals can be formed with different quantities of water of crystallisation, the transition-temperature may exhibit a maximum or minimum. In this case, the proportion of the isomorphous salts must be the same in the two types of crystals, and *also in the solution.* This is contrary to the view previously put forward that there would be a different proportion in the liquid. [See Abstract No. 2289 (1902).] T. M. L.

1496. *Solubility of Phenylthiourea and of Boric Acid in Water.* **P. Bogdan.** (Annales Scientifiques de l'Univ. de Jassy, 2. pp. 95–118, March, 1903.)—The solubility of phenylthiourea in water at 25° is 2·547 gm. per litre. It is increased by the addition of non-electrolytes, and in the following table L gives the solubility in grams per litre in presence of *a* gram-molecules per litre of the non-electrolyte; C gives the increment of solubility per gram-molecule—

	a.	L.	C.
Propyl alcohol	1·035	3·587	1·01
	0·1059	2·643	0·91
Cane sugar	0·9893	3·457	0·94
	0·1004	2·634	0·87
Urea	1·0495	3·306	0·72
	0·1020	2·618	0·70
Ethyl alcohol	1·1010	3·193	0·59
	0·1094	2·629	0·67
Acetone	0·1288	2·667	0·92
Mannitol	1·000	3·04	0·49
Dextrose	1·002	3·042	0·45
	0·1000	2·654	0·64

The solubility at 0° is 1·000 gm. per litre, and the increase of solubility at this temperature is shown by the table—

	a.	L.	C.
Cane sugar	1·000	1·42	0·42
	0·100	1·044	0·44
Urea	1·000	1·31	0·31
	0·100	1·048	0·48
Propyl alcohol	1·000	1·21	0·21
	0·100	1·047	0·47

At this temperature the three substances produce practically the same effect in decinormal solutions, though great variations occur in the normal solutions, as also in the measurements made at 25°. Sodium and potassium nitrates decrease the solubility of phenylthiourea, though the effect is imperceptible in decinormal solutions. The solubility at 25° was reduced from 2·55 to 2·38 by 1·045N KNO, and to 2·28 by 1·024N $NaNO_3$. The solubility of boric acid in water (57·58 g. per litre at 25°) is increased by both electrolytes and non-electrolytes, as is shown by the table—

	a.	L.
Urea	1·000	63·08
Acetone	1·000	62·70
Propyl alcohol	0·579	59·10
KCl	1·0042	62·50
NaCl	1·1555	57·20
KNO_3	1·0021	65·46
$NaNO_3$	1·0013	60·40
K_2SO_4	0·4946*	74·54
Na_2SO_4	0·4536*	67·77

* g.-mol. per 1,000 g. water.

T. M. L.

1497. *Stereochemistry of Benzene.* **H. O. Jones** and **J. Kewley.** (Cambridge Phil. Soc., Proc. 12. pp. 122–124, April, 1903.)—According to the constitutional formulæ for benzene proposed by Ladenburg, Claus and Vaubel, in which the six carbon atoms do not lie in one plane and each is singly linked to three other carbon atoms, all meta-disubstituted derivatives and all trisubstituted derivatives have no plane of symmetry, and should hence be capable of existing in two exantiomorphously related optically active forms. The authors give results of experiments in which attempts were made to resolve such derivatives of a basic nature into their components by means of *d*-camphorsulphonic and *d*-bromo-camphorsulphonic acids acting in a non-dissociating solvent. The results obtained for the specific rotations agree perfectly with the numbers calculated for the rotations of salts of these acids with inactive bases, and these latter, when set free by the action of potassium hydroxide, are also found to be quite inactive. The above-mentioned formulæ for benzene, representing the six carbon atoms as not co-planar, must be rejected. T. H. P.

1498. *Physical Properties of Nickel Carbonyl.* **J. Dewar** and **H. O. Jones.** (Roy. Soc., Proc. 71. pp. 427–439, April 30, 1903.)—It has been shown by Mond, Langer, and Quincke, that nickel carbonyl explodes at 60° with a flash of light, the decomposition products containing carbon dioxide. The authors find that such explosive decomposition does not occur in presence of an inert gas, and they give results of vapour density determinations of nickel carbonyl, made by Victor Meyer's method, in atmospheres of hydrogen, nitrogen, and ethylene, at temperatures ranging from 63° to 216°. Carbon monoxide was also made use of to study the influence of the gaseous dissociation product of the nickel carbonyl. The vapour density is greatest in the carbon monoxide atmosphere, while in nitrogen or hydrogen it is less than in ethylene. In nitrogen, dissociation of the nickel carbonyl is practically complete at 155°, whilst in carbon monoxide the vapour density is nearly normal at 100°, and even at 182° dissociation is incomplete. Determinations, by Hofmann's method, of the vapour density of the undiluted carbonyl show that at 182° dissociation is virtually complete. The temperature at which the meniscus of nickel carbonyl disappears and reappears in a sealed tube varies from 191° to 195°, and correcting for the carbon monoxide present, the true critical temperature is estimated to be about 200°; the critical pressure is about 30 atmospheres. From determinations, by a statical method, of the vapour pressure, p, of nickel carbonyl between $-9°$ and $+30°$, the relation between p and the absolute temperature T is found to be expressed by: $\log p = 7{\cdot}355 - 1415/T$. This gives a calculated boiling-point of 43·2°, actual measurements yielding the values 43·2°–43·33° under 769 mm. pressure. The curve obtained by the authors is more accurate than that of Mittasch. [See Abstract No. 1733 (1902).] The above formula gives, by extrapolation, a pressure of 30 atmospheres corresponding with the temperature 200°.

T. H. P.

1499. *Colour Changes in Mercury Iodide.* **D. Gernez.** (Comptes Rendus, 136. pp. 889–891, April 6, 1903.)—The author describes the sudden and slow colour changes of the red and yellow modifications of this salt. Cooled down to −80° C, the red iodide turns yellow without changing its quadratic crystals into orthorhombic crystals; reheated it becomes red again. The yellow modification turns almost white in liquid air. H. B.

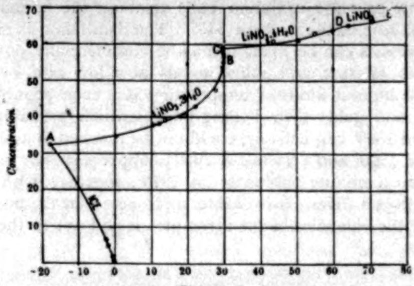
1500. *Evaporation and Boiling of Metals in Exhausted Quartz Glass Tubes in the Electric Furnace.* **F. Krafft.** (Ber. Deut. Chem. Gesell. 36. pp. 1690–1714, May 23, 1903.)—This paper is of interest as showing the great advances that have recently been made in chemical manipulation. Transparent tubes of quartz can be used readily up to 1200° and with care up to 1400°, even when exhausted to the very low vacuum required for the production of the kathode light in a vacuum tube. The fused quartz is marvellously resistant, it shows no slightest tendency to crack where the tube emerges from the furnace, and it is even possible to take from the furnace a tube half full of metal, allow it to cool rapidly in the air and replace it directly in the furnace at 1200° without any risk of cracking. The use of an electric furnace not only allows the temperature to be regulated within 2 or 3° from 20° to 1400°, but so far localises the high temperature that a ground-glass joint can be kept tight by means of wax, even when within 3 or 4 in. of the hottest part of the furnace. In a completely exhausted tube metals boil quite regularly under the pressure of the short column of their own vapour, which forms a limited metallic atmosphere extending only from the surface of the metal to the point just outside the furnace where complete condensation occurs. Under this exceedingly low pressure cadmium boils at about the normal boiling-point of sulphur, and zinc distils at about 545°. The distillation is rapid and when larger quartz-vessels can be made it may be commercially possible to purify large quantities of zinc and other metals at a low rate by this method. Working at the highest limits of temperature it is even possible to vapourise silver, copper and gold; their boiling-points, which probably lie at about 1400°, 1600° and 1800° respectively, could not be reached, but silver evaporates fairly rapidly at 1200° and very fast at 1340°, copper distils slowly at 1330°, and even gold gave a minute sublimate at 1375°, together with a larger film consisting of alloyed silver. It is of interest to note that the boiling-points are in the order of the valencies of the three metals and not in the order of their atomic weights. T. M. L.

1501. *Catalytic Decomposition of Saturated Primary Alcohols by Finely-divided Metals.* **P. Sabatier** and **J. B. Senderens.** (Comptes Rendus, 136. pp. 921–924, April 14, 1903.)—Primary saturated alcohols are decomposed by reduced copper into hydrogen and the corresponding aldehyde, which may conveniently be prepared in this way. The composition of the alcohols commences at about 200–240°, and at higher temperatures the aldehyde is resolved, to a greater or less extent, into carbon monoxide and a hydrocarbon; this decomposition of the aldehyde is complete at about 400°. When reduced nickel is employed, the action is more violent and, although it takes place at a lower temperature than with copper, it is impossible to prevent more or less decomposition of the aldehyde, the carbon monoxide thus formed being attacked by the nickel. Cobalt acts similarly to nickel. Platinum sponge requires a higher temperature than copper for the decomposition of alcohols, so that in this case more of the aldehyde is destroyed. [See Abstract No. 1273 (1903).] T. H. P.

1502. *Catalytic Decomposition of Secondary and Tertiary Alcohols by Finely-divided Metals.* **P. Sabatier** and **J. B. Senderens.** (Comptes Rendus, 136. pp. 983–986, April 27, 1903.)—Allyl and benzyl alcohols are decomposed by heated reduced copper with formation of an aldehyde, but various secondary reactions take place. [See preceding Abstract.] Secondary alcohols are similarly decomposed by reduced metals, but the reactions are here simpler, owing to the greater stability of the ketones formed. Tertiary alcohols, under these conditions, yield water and an unsaturated hydrocarbon. T. H. P.

1503. *Catalytic Racemisation of Amygdalin.* **J. W. Walker.** (Chem. Soc., Journ. 83. and 84. pp. 472–479, April, 1903.)—Water containing in solution a small quantity of an alkali hydroxide or carbonate, or of an alkaline earth, dissolves amygdalin much more readily than pure water. From the results of polarimetric measurements of the hydrolysis of amygdalin and amygdalinic acid, the author concludes that the glucoside is racemised in alkaline solution by virtue of the catalytic action of the hydroxyl ions and that amygdalinic acid is racemic as regards its asymmetric carbon atom. T. H. P.

1504. *Solubilities and Transition Points of Lithium Nitrate and its Hydrates.* **F. G. Donnan** and **B. C. Burt.** (Chem. Soc., Journ. 83. and 84. pp. 335–342, March, 1903.)—The solubility curve of lithium nitrate has the form shown in the figure. The eutectic temperature A lies at —17·8° and the melting-point B of the hydrate $LiNO_3 \cdot 3H_2O$ at 29·88°; the eutectic temperature C for the trihydrate and half-hydrate lies at 29·6°, only 0·3° below the melting-point of the former; finally, the transition temperature, above which the anhydrous salt is stable, is at 61·1°. T. M. L.



Solubility-curves of the system, $LiNO_3$—H_2O.

1505. *Absorption Compounds.* **J. M. van Bemmelen.** (Konink. Akad. Wetensch. Amsterdam, Versl. 12. pp. 111–122, June, 27, 1903.)—In the case of colloids absorbing certain amounts of acids, bases and salt solution in their structure, the quantity of matter absorbed will depend, first, on the nature of the structure, susceptible of undergoing many variations; secondly, on the kind of substance absorbed; thirdly, on the concentration of the final solution, solutions of continually increasing concentration in the substance to be absorbed being necessary for the absorption to continue, and, fourthly, on the temperature. In previous papers the author had shown why these compounds should not be considered as chemical compounds, where all the components are bound to one another with the same force and according to definite proportions, but as an absorption of acid, bases, salt, &c. in the structure, in any proportions, so that the binding, though very strong for small amounts, becomes smaller as the absorption increases. These compounds were termed absorption compounds. In this paper the author communicates some researches where the substance absorbed, in addition to forming an absorption compound with a colloid, is capable of forming either a chemical compound or a solution. Experiments on the hydrogel of Fe_2O_3 in baryta solutions go to show that, for the same colloid, the absorption, instead of exhibiting the behaviour of a chemical compound, is determined by the equilibrium constant of the solution. Moreover, the concentration of the final solution is shown to increase to a much higher degree than the concentration of the hydrogel with regard to the absorbed substance, the state of the iron oxide influencing the absorption coefficient. On the other hand, with the hydrosol of SiO_2 in baryta solution, small amounts of baryta will cause the silicic acid to coagulate. In the case of baryta being present at the outset, the hydrogel with the absorbed baryta is shown to be converted rapidly and wholly into crystals of barium silicate, a chemical compound.

A. G.

1506. *Relationship between Constitution and Cryoscopic Character of Solvents.* **K. Auwers.** (Zeitschr. Phys. Chem. 42. pp. 513–544, Feb., 1903.)—The abnormal molecular weights of phenols and amides in freezing benzene solution become less pronounced in substituted benzenes. Methyl-groups produce little effect, and *p*-xylene gives results almost identical with those obtained with benzene as solvent. A single halogen atom produces scarcely more effect, but two halogens distinctly reduce the abnormality; iodine produces most effect and chlorine least. Nitro-groups greatly weaken the cryoscopic character of the hydrocarbon, and carbothoxy- and carbomethoxy-groups are still more powerful. Finally, the introduction of the groups $-NH_2$, $-OH$, and $-CO_2H$ entirely destroys the characteristic behaviour of the hydrocarbon, and when amines, phenols, and acids are used as solvents, all substances show a normal cryoscopic character. Precisely similar rules hold good for the solutes, though the effects are in the opposite direction. The abnormal behaviour of phenols and amides is increased but little by the introduction of methyl and halogen radicles, considerably more by the nitro-group, and very greatly by the groups $-CO_2Me$, $-CN$, $-CHO$, and $-NH_2$; the $-OH$ and $-CO_2H$ groups are the most powerful, and are the typical radicles on which the abnormality depends. In both cases the radicles can therefore be arranged in the same order of increasing activity, viz., CH_3, Cl, Br, I, NO_2, CO_2R, CN, CHO, NH_2, CO_2H, OH. T. M. L.

1507. *Colour Changes Observed in some Cobalt Salts.* **W. N. Hartley.** (Chem. Soc., Journ. 83. and 84. pp. 401–405, April, 1903.)—The author disagrees with certain conclusions drawn by Donnan and Bassett in a recent paper upon the composition of cobalt salts in solution. His reasons are, however, based in the main only upon absorption spectra. [See Abstract No. 270 (1903).] E. C. C. B.

1508. *Resistance of the Ions, and Mechanical Friction of the Solvent.* **F. Kohlrausch.** (Roy. Soc., Proc. 71. pp. 338–350, April 7, 1903.)—The temperature-coefficients of conductivity for aqueous solutions of N/10000 strength are substantially identical with those of solutions in which ionisation is complete, but owing to uncertainty as to the proper way of correcting for the conductivity of the water, it is more satisfactory to make comparisons on solutions of N/1000 strength. The conductivities between $+2^\circ$ and $+34^\circ$ may be expressed by a quadratic formula, and the conductivity-temperature curves for N/1000 solutions converge to a common point at -43°; this point is not on the axis of temperature, but slightly above it. When the fluidity of water is expressed by a similar formula, the temperature-coefficients ($\alpha = 0{\cdot}0249$, $\beta = 0{\cdot}000111$) are found to be substantially identical with those of sodium valerate ($\alpha = 0{\cdot}0244$, $\beta = 0{\cdot}000111$), the poorest conductor of the series of salts examined; the salts of higher conductivity and the more mobile ions have higher temperature-coefficients. In order to explain these relationships it is suggested that each ion is surrounded by a watery atmosphere, and that the frictional resistance which opposes electrolysis increases with the size of the envelope; in the case of the most sluggish ions the envelope is so thick that the individuality of the ion is entirely concealed, and the temperature-coefficient of ionic mobility of conductivity is identical with that of the fluidity of the solvent; the more mobile ions are less completely surrounded and have larger coefficients depending on the character of the ion, and increasing with the mobility of the ion. T. M. L.

1509. *Molecular Rearrangement of N-substituted Iminoethers.* **G. D. Lander.** (Chem. Soc., Journ. 83. and 84. pp. 406–414, April, 1903.)—The author finds, in general confirmation of previous results, that the isomeric change of the open-chain compounds occurs most easily under the catalytic influence of alkyl iodides, but also appears to take place by simple heating. S. R.

1510. *Velocity of Interaction of Bromine and Ethyl Alcohol.* **S. Bugarszky.** (Zeitschr. Phys. Chem. 42. pp. 545–566, Feb., 1903. From the Chem. Laboratorium d. Tierärztlichen Hochschule, Budapest.)—Measurements have been made of the velocity of interaction of bromine and ethyl alcohol between 0 and 30°, in continuation of the measurements already made at 25° [see Abstract No. 118 (1902)]. The change proceeds according to the equation, $2Br_2 + 2C_2H_5OH = C_2H_5 . O . CO . CH_3 + 4HBr$, but is checked by the combination of the HBr and Br_2 to form a compound HBr_3.

The velocity-constant K of the interaction between the bromine and alcohol dissociation-constant *k* of the hydrogen tribromide HBr_3 at different temperatures are given in the table—

T	K	*k*
0	0·00690	0·00198
10	0·0210	0·00309
20	0·0640	0·00403
25	0·1052	0·00444
30	0·182	0·00495

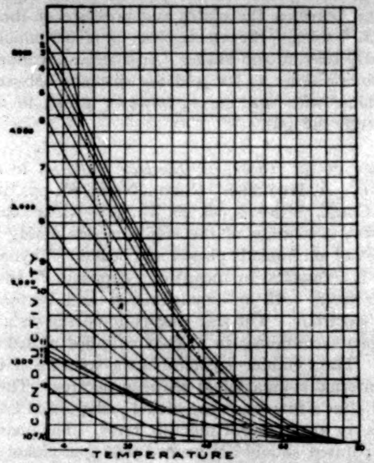
A rise of 10° in temperature thus increases the velocity about threefold; the velocity-constant can be calculated from the formula $\log K = 0{\cdot}04753t - 2{\cdot}1552$. The dissociation-constant *k* of the HBr obeys a linear law and can be calculated from the formula $k = 0{\cdot}00204 + 0{\cdot}0000975t$. Making use of van't Hoff's formula, the heat of formation of HBr in absolute alcoholic solution is calculated to be 6,026 calories, whilst an experimental determination gave the value 6,085 calories. T. M. L.

1511. *Effects Produced by Positive Ions.* **J. S. Townsend.** (Electrician, 50. p. 791, April 3, 1903.)—In former papers the author and P. J. Kirkby have described experiments in illustration and development of the author's theory of the production of ions by collisions. [See Abstracts Nos. 1347 and 1351 (1902)]. That theory, as originally announced, dealt only with the motion of negative ions, but the author has now developed it further to take into account any possible action of the positive ions, and his experiments have led him to the conclusion that the positive ions generated in a gas will produce others by collision with the molecules, even when the electric force is less than that necessary to produce a discharge. The author outlines the method of verifying his theory experimentally, and obtains results which are in close agreement with theoretical values. The equations given by this theory have many interesting applications; it is possible, for example, to find from them the minimum distance at which a continuous discharge takes place in a gas, lasting after the supply of initial ions has been stopped, when the electric force and the pressure of the gas are given. In the author's experiments on minimum sparking distances for different forces and pressures, the distance has in no case differed by more than 2 per cent. from that given by the theoretical formula. The equations, again, show that the minimum potential at which a discharge takes place between parallel plates depends only on the product of distance between the plates and pressure of the gas or on the quantity of the gas between the electrodes: a result which was obtained experimentally by De La Rue and Müller. Another application of the formula shows that when the pressure is low and the distance between the plates is small, it is impossible with any e.m.f., however great, to make any large current pass through the gas. W. C. H.

1512. *Application of the Theory of Electric Batteries to the Quantitative Separation of Metals.* **A. Hollard.** (Chem. News, 87. pp. 193–194, April 24, 1903. Bull. Soc. Chim., Series 3, vol. 29, No. 3.)—Nickel can be separated from zinc as follows: A solution of the sulphates containing ammonium sulphate and an excess of ammonia is placed in a beaker. A cylindrical electrode of platinum gauze is connected by means of a copper wire, insulated along its length with indiarubber, with an amalgamated and perforated zinc disc forming the other electrode. The zinc disc is immersed in a strong solution of magnesium sulphate contained in a glass cylinder closed at one end with parchment paper. This cylinder is placed in the solution of the sulphates so that it forms the internal compartment of the apparatus. The temperature is kept at 95° C., and after a few hours the nickel is deposited completely on the platinum electrode in an adherent metallic layer. The quantities of nickel and zinc to be separated should not exceed 0·45 gm. nickel and 1 gm. zinc, otherwise the deposited nickel contains some zinc. This is accounted for by the author by means of Nernst's formula, various secondary processes being taken into account. The method can be extended in certain cases to the separation of other metals. T. S. P.

1513. *Electrolysis of Potassium Iodide Solutions.* **F. Foerster** and **K. Gyr.** (Zeitschr. Elektrochem. 9. pp. 215–226, March 12, 1903. From the Elektrochemischen Laboratorium der Technischen Hochschule, Dresden.)—The results obtained by the authors are as follows: The least potential necessary for the decomposition of an alkaline solution of potassium iodide is less than that necessary for a neutral solution because the alkali acts as a depolariser, hypoiodous acid and hypoiodite being formed. During the electrolysis of neutral solutions small quantities of free iodine and alkali remain in equilibrium with the hypoiodous acid, but the greater part of the hypoiodite is transformed into iodate. If the solution is alkaline to begin with, the hypoiodite first formed is more stable up to a certain concentration which depends on the current strength used, on the concentration of the iodide and alkali, and on the temperature. Once this concentration has been reached, the hypoiodite is transformed into iodate as fast as it is formed. Very dilute alkaline solutions of potassium iodide yield oxygen at the anode, especially when the latter is blank; this production of oxygen is favoured by increase in the alkalinity of the solution, and by high current density and high temperature. Periodates are not formed except in the smallest traces. The authors give a theoretical discussion of the above results and also details of the conditions to be observed in the preparation of iodates by electrolysis. T. S. P.

1514. *Dependence of Electrolytic Conductivity on Temperature below* 0°. **J. Kunz.** (Zeitschr. Phys. Chem. 42. pp. 591–596, Feb., 1903. Extract from Inaugural Dissertation, Zürich, 1902.)—Kohlrausch has shown that the conductivity-temperature curves of dilute aqueous solutions, &c., measured between 2° and 34°, and expressed by a parabolic formula, point to a zero conductivity if extrapolated to — 39°. The curves for a number of solutions of which the conductivity was measured between 0° and —80°, are reproduced in the Figure, and indicate that in these concentrated solutions the conductivity diminishes more and more slowly as the temperature falls, so that the curves, instead of cutting the axis of temperature, become almost asymptotic to it. The dotted curve A shows the decrease in conductivity of a (partially) frozen solution, whilst B shows the result of extrapolating by means of a parabolic formula from values determined between 0° and — 28°.



Substance.	No. of Curve.	Concentration per cent.
H_2SO_4	1	19·10
„	2	28·00
„	3	32·66
„	4	37·27
„	5	42·05
„	6	45·49
„	7	50·86
„	8	56·26
„	9	60·90
„	10	63·76
„	11	70·43
$CaCl_2$	12	25·5
„	13	29·0
NaOH	14	27·11
„	15	32·70

T. M. L.

1515. *Osmotic Pressure of a Solution of Variable Density.* **M. Planck.** (Zeitschr. Phys. Chem. 42. pp. 584–590, Feb., 1903.)—Attention is called to the fact that the osmotic pressure of a solution may have a different value according as the solvent on one side of the semi-permeable membrane is under its own vapour pressure p_0, or under some arbitrary pressure p_1, such as the pressure of the atmosphere. This difference depends on the unequal compressibility of solvent and solution, and it is calculated that in the case of 50 per cent. aqueous KOH the difference amounts to 59 mm., though this must be a very small fraction of the osmotic pressure. T. M. L.

1516. *Periodic Contact Catalysis.* **G. Bredig** and **J. Weinmayr.** (Zeitschr. Phys. Chem. 42. pp. 601–611, Feb., 1903. From the Verhandlungen des naturhist. mediz. Vereines zu Heidelberg, N.F. vii.)—The rate of decomposition of hydrogen dioxide in contact with mercury is periodic, as may be shown very simply by pouring 10 c.cm. of a 10–11 per cent. solution of H_2O_2 over a few c.cm. of mercury contained in a test-tube; a bright bronze-like film (probably of mercuric oxide) soon forms on the mercury; after a while vigorous evolution of gas occurs (and the film is obscured), to be followed by a slackening during which the film is once more visible, and then by a fresh period of activity during which it is again lost to sight, and so on at the rate of about 20 vibrations per minute in experiments at the ordinary temperature. The chemical periodicity is accompanied by periodic changes of potential and surface tension at the mercury surface. D. H. J.

1517. *New Method for carrying out Pyrochemical Reactions.* **E. Rasch.** (Zeitschr. Elektrochem. 9. pp. 162–164, Feb. 19, 1903.)—The use of the electric furnace for chemical reactions is limited by the fact that the carbon electrodes or resistances act as reducing agents, so that reactions involving oxidation processes cannot be carried out. The author suggests the replacement of carbon by difficultly fusible oxides similar to those used in the Nernst lamp. It would be necessary to previously heat these oxides to make them conduct. The temperatures obtained when such pyrochemical resistances are used are very high, being more than 500° C. above the melting-point of platinum. An arc can be maintained between electrodes of such material with 40 volts, and the temperature is probably higher than that of the arc between carbon electrodes. It should also be possible to carry out reactions in which the electrodes take part. T. S. P.

1518. *Electrolytic Estimation of Mercury: Solubility of Platinum in Potassium Cyanide.* **F. Glaser.** (Zeitschr. Elektrochem. 9. pp. 11–17, Jan. 1, 1903. Communication from the electrochemical laboratory of the Tech. Hochschule, Karlsruhe.)—In determining mercury by electrolysis, normal values are obtained with nitrate and sulphate solutions, but low values when cyanide solutions are used. This cannot be due to volatilisation of the mercury, as this should occur in both solutions, and the measured rate of volatilisation was much too small. Ultimately it was found that, in a series of experiments in which the apparent deficiency of mercury had amounted to 0·0697 gm., the platinum dish used as anode had lost 0·0656 gm., and the solution contained 0·0645 gm. of platinum in solution. This source of error can be almost entirely eliminated by reducing the current from 0·8 to 0·1 ampere. A series of experiments showed that, unlike silver and gold, platinum dissolves in potassium cyanide solutions with liberation of hydrogen, a result that is ascribed to the great stability of the resulting platinocyanide $K_2Pt(CN)_4$, as compared with the auricyanide and argenticyanide which are only formed in presence of oxygen. The dissolution of the platinum is not influenced by the presence of mercury, but is greatly facilitated by potassium amalgam, which is formed during the electrolysis of mercury in potassium cyanide solutions. T. M. L.

1519. *Decomposition-Curves of Copper Salt Solutions.* **M. E. Heiberg.** (Zeitschr. Elektrochem. 9. pp. 137–139, Feb. 12, 1903.)—The decomposition-voltage of copper solutions was found to be the same for solutions of copper sulphate prepared by seven different methods and containing free sulphuric acid. It was found, however, that in some cases a considerable increase of current occurred at 0·1 volt below the decomposition voltage, and that this increase disappeared when the measurements were repeated immediately, with the same solution. It is suggested that the solution contains at first a larger proportion of cuprous salt than is required for equilibrium and that this is eliminated by electrolysis. No such effects could be detected in electrolysing silver nitrate, and the abnormally high deposit of silver obtained from old solutions of silver nitrate is not due to this cause.

T. M. L.

1520. *New Electrochemical Synthesis of Hydrocyanic Acid.* **J. Gruszkiewicz.** (Zeitschr. Elektrochem. 9. pp. 83–85, Jan. 22, 1903. From the Physikal. Institut der Universität Freiburg.)—According to Berthelot, the synthesis of hydrocyanic acid can be carried out by the passage of electric sparks through a mixture of acetylene and nitrogen, the deposition of carbon being prevented by the addition of hydrogen. The author finds that the concentration of the acetylene must not exceed 5 per cent., otherwise carbon is deposited ; the mixture used consists of 5 per cent. acetylene, 5 per cent. nitrogen, 90 per cent. hydrogen. The author also shows that hydrocyanic acid is produced when electric sparks are passed through a mixture of carbon monoxide, hydrogen, and nitrogen. Theoretically, the required mixture should contain 33·34 per cent. CO, 50·00 per cent. H_2, 16·66 per cent. N_2, but such a mixture gives no hydrocyanic acid. If the percentage of carbon monoxide is increased, hydrocyanic acid is formed, an alteration from 38·44 per cent. to 49·79 per cent., increasing the yield of hydrocyanic acid tenfold. Three litres of the mixture, 54·62 per cent. CO, 24·88 per cent. N_2, 20·50 per cent. H_2, give 0·4 per cent. hydrocyanic acid on being passed in a continuous stream through the spark gap, the experiment lasting one hour. Since such gas mixtures are used in technical processes, *e.g.*, water gas, Dowson gas, &c., the author considers they could be used for the commercial preparation of cyanides in the above manner. T. S. P.

1521. *Molecular Induction.* **T. Gross.** (Deutsch. Phys. Gesell., Verh. 1. pp. 39–48, Jan. 15, 1903.)—A rectangular glass trough, 23 cm. long, 13 cm. wide, and 14 cm. high, is filled with a pure concentrated solution of copper sulphate to a height of 12 cm. At the middle of either end, copper wires of 1 mm. diameter are hung so that they do not quite reach the bottom of the trough, and are connected with a galvanometer. A rectangular plate of zinc sheet, 0·7 mm. thick, standing higher than the glass trough and a few mm. less in diameter, is then fixed across the latter at a distance of about 2 cm. from the one electrode. Copper is deposited on the zinc plate, and at the same time a current passes through the solution from the copper electrode near the zinc plate to the other. The current can be reversed by taking the zinc plate out of the solution and placing it nearer to the other electrode; if it is simply moved through the solution from one electrode to the other the direction of the current becomes uncertain. If the zinc plate is coated with a mixture of colophonium and wax on the one side, so as to limit the deposition of the copper, the current flows from the electrode on the waxed side to the other one, and its direction is independent of the position of the zinc plate in the trough. The e.m.f. is from 0·3–0·6 volt, and remains constant for at least 15 minutes. The current is very sensitive to movements of the zinc plate or to shakings of the trough, sometimes being increased and sometimes being decreased thereby. The current is electrolytic in nature, the loss in weight of the anode being equal to the increase in weight of the kathode.

The author considers that the current is not due to chemical or concentration differences in the solution, nor is it a thermo-current, but is produced as follows: Since copper is deposited on the clean side of the zinc plate, the copper of the sulphate solution is drawn towards it, and there is consequently a molecular movement of the copper from the electrode opposite the clean side towards the latter. The kinetic energy of this movement supplies the energy for the current. T. S. P.

1522. *Artificial Diamonds.* **Gellendien.** (Zeitschr. Vereines Deutsch. Ing. 46. pp. 1709–1711, Nov. 8, 1902. Paper read before the Sächsisch-Anhaltinischer Bezirksverein.)—An account is given of the experiments of Ludwig on the preparation of artificial diamonds. Attempts were first made by heating carbon under high pressure, an electric arc being formed between carbon electrodes which were enclosed in a special apparatus for obtaining high pressures (1,200–3,000 atmospheres), containing an inert atmosphere of hydrogen. Under these conditions, carbon becomes a non-conductor, probably because diamond is formed, and this, like all transparent elementary bodies, is a non-conductor. At the same time the charcoal of the electrode partly melts and forms pure graphite. Special electrodes of hollow gas carbon, the conduction being brought about by using an iron filling, do not give much better results, even with currents of 150 amperes and pressures up to 3,000 atmospheres. Occasionally a few very small, semi-transparent crystals are formed which have the specific gravity of diamonds, their formation being probably due to a sudden local cooling which had taken place. Sudden cooling, combined with high temperature and pressure, leads to better results; this is effected either by allowing the compressed hydrogen (at 2,600 atmospheres) to suddenly expand or by squirting water into the apparatus. In the latter case white transparent crystals are obtained which have the properties of diamonds. In all cases the yield is very small indeed. The conditions for the formation of diamonds are thus high pressure and temperature and very sudden cooling. Diamonds are an unstable form of carbon. T. S. P.

REFERENCES.

1523. *Isothermals of Diatomic Gases and their Binary Mixtures. V.* **H. K. Kammerlingh Onnes** and **H. H. F. Hyndman.** (Konink. Akad. Wetensch. Amsterdam, Versl. 11. pp. 747–754, March 28, 1903.)—Continuing their researches on the isothermals of diatomic gases and their binary mixtures, the authors give a full description of accurate volumenometers and mixing devices used in the Leyden Physical Laboratory. [See also Abstract No. 1699 (1902).] A. G.

1524. *Contribution to the Knowledge of van der Waals' ψ-Surface.* **J. E. Verschaffelt.** (Konink. Akad. Wetensch. Amsterdam, Versl. 11. pp. 663–667, Feb. 28, 1903.)—Continuing his researches on the above subject [see Abstract No. 449 (1903)], the author derives the state equation and the ψ-surface, in the immediate neighbourhood of the critical state, for binary mixtures containing small amounts of either of the components, the ψ-surface in the immediate neighbourhood of a folding point being more especially studied, and the results applied to special formulæ found by Korteweg. A. G.

1525. *Methods and Resources of Leyden Cryogen Laboratory. IV.* **Kamerlingh Onnes.** (Konink. Akad. Wetensch. Amsterdam, Versl. 11. pp. 667–675, Feb. 28, 1903.)—Continuing his description of the methods and experimental apparatus in use at the above laboratory [see Abstract No. 772 (1903)], the author describes a way of obtaining baths of very uniform and constant low temperature in the cryostat, permanent baths of liquid nitrogen both under atmospheric and lower pressures, and finally, the arrangement of a Burckhardt-Weiss vacuum pump for obtaining circulation at low temperatures. A. G.

1526. *Basis of the Theory of Solutions.* **M. Planck.** (Ann. d. Physik, 10. 2. pp. 436–445, Jan. 27, 1903.)—A reply to Cantor's criticisms. [See Abstract No. 1285 (1903).] T. M. L.

1527. *Secondary Electrolytic Reactions.* **J. W. Richards.** (Elektrochem. Zeitschr. 9. pp. 117–122, Sept., and pp. 144–149, Oct., 1902.)—A theoretical treatise on the subject of primary and secondary electrolytic reactions, based upon thermochemical calculations. [See also Abstract No. 921 (1902).] O. J. S.

1528. *Vacuum Apparatus for Electrolysis of Solutions which Evolve Gases during Electrolysis.* **W. Barnes.** (Elektrochem. Zeitschr. 9. pp. 205–208, Jan., 1903.)—The author describes and illustrates an apparatus by which the gases are evolved under diminished pressure and can be easily collected. S. R.

1529. *Methods and Resources of Leyden Cryogen Laboratory. VI.* **Kamerlingh Onnes.** (Konink. Akad. Wetensch. Amsterdam, Versl. 12. pp. 247–257, June 27, 1903.)—In a former article on the experimental methods in use at this laboratory [see Abstract No. 772 (1903)] the author drew attention to the fact that in a cascade of circulations, giving the permanent bath of liquid oxygen for different measurements, the refrigerator containing methyl chloride did not work very satisfactorily. The improvements since made are described, the cascade method being rendered available in practice by the addition of regenerators. A. G.

1530. *Tungsten Bronzes.* **E. Engels.** (Zeitschr. Anorg. Chem. 37. 1. pp. 125–152, Oct. 27, 1903.)—The author deals with the liability of sodium and potassium-tungsten bronzes to form double bronzes with the earth metals barium, strontium, and calcium, nine such compounds being obtained and examined. A. G.

1531. *Connection between Metals and Non-metals.* **G. Martin.** (Chem. News, 86. pp. 295–296, Dec. 19, 1902.)—The author suggests that a low temperature should transform metals into non-metals.

1532. *Connection between Metals and Non-metals, and its Bearing on the Valence Theory of Helmholtz and on Stereo-Chemistry.* **G. Martin.** (Chem. News, 87. pp. 162–163, April 3, 1903.)—The author has suggested [see preceding Abstract] that a low temperature should transform metals into non-metals. In this paper he deduces further arguments from the connection between colour, valency, and the theory of electrons. S. R.